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AUSTROADS RESEARCH REPORT

Bus-Bike Interaction within the Road Network




Austroads
promoting improved road transport outcomes

BUS-BIKE INTERACTION WITHIN THE ROAD NETWORK

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BUS-BIKE INTERACTION WITHIN THE ROAD NETWORK

Austroads
Sydney 2005

Austroads profile

Austroads is the association of Australian and New Zealand road transport and traffic authorities whose purpose is to contribute to the achievement of improved Australian and New Zealand road transport outcomes by:

- undertaking nationally strategic research on behalf of Australasian road agencies and communicating outcomes
- promoting improved practice by Australasian road agencies
- facilitating collaboration between road agencies to avoid duplication
- promoting harmonisation, consistency and uniformity in road and related operations
- providing expert advice to the Australian Transport Council (ATC) and the Standing Committee on Transport (SCOT).

Austroads membership

Austroads membership comprises the six state and two territory road transport and traffic authorities and the Commonwealth Department of Transport and Regional Services in Australia, the Australian Local Government Association and Transit New Zealand. It is governed by a council consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

- Roads and Traffic Authority New South Wales
- Roads Corporation Victoria
- Department of Main Roads Queensland
- Main Roads Western Australia
- Department of Transport and Urban Planning South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Infrastructure, Planning and Environment Northern Territory
- Department of Urban Services Australian Capital Territory
- Commonwealth Department of Transport and Regional Services
- Australian Local Government Association
- Transit New Zealand

The success of Austroads is derived from the collaboration of member organisations and others in the road industry. It aims to be the Australasian leader in providing high quality information, advice and fostering research in the road sector.

EXECUTIVE SUMMARY

Buses and Bikes are at opposite ends of the spectrum in terms of size, mass and manoeuvrability but frequently operate in the same road space, especially adjacent to the kerb and at intersections. Both buses and bicycles are effective alternatives to the private car for travel in our towns and cities and are being promoted by governments on this basis, but they can come into conflict as well as working together.

This report reviews the interaction between buses and bicycles within the road network and suggests ways in which any adverse impacts on cyclists or bus operators and passengers can be minimised.

Issues and ways of addressing them were identified in consultation with both bus and bicycle stakeholders, to ensure that the outcomes reflected a balanced view of bus-bike interaction.

Urban transport strategies for major cities in Australia and overseas focus heavily on reducing , or at least reducing the growth in, car traffic, for a range of social, environmental and economic reasons. A reasonable presumption for the green modes of transport (walking, cycling and public transport), therefore, is that one should not be given priority at the expense of another, and that where a project may have this effect it should be redefined to ameliorate the adverse impact or provide an appropriate alternative.

At the strategic planning level, the interaction of bikes and buses is most frequently seen in terms of the potential of the bicycle, as a feeder mode, to expand the catchments for public transport, although the emphasis has most often been on train stations rather than tram or bus stops.

In terms of planning and design guidance, most attention has been paid to the co-existence of bikes and buses in transit along the roadway. Key issues in this respect include:

- the extent of separation (if any) between bikes and buses; and
- treatment at bus stops – with respect to bikes passing buses and potential conflict with boarding/alighting passengers.

Where there is no physical separation of bus and bicycle facilities, the general practice is to allow bicycles to use a bus lane. Western Australia appears to be a sole exception, with its current practice at odds with that adopted either formally (through regulation) or informally (through the way in which regulations are applied) in other Australia jurisdictions and overseas. A trial of allowing bikes to travel in a bus lane will be undertaken in Western Australia during 2005, on Beaufort Street, Inglewood.

Whilst the Dutch guidelines indicate that shared use only occurs over short lengths of roadway, others do not suggest any maximum length of bus lane to which they apply. This is important given that the likelihood of a bus being delayed by a cyclist will, other things being equal, increase with the distance for which the facility is shared, as well as the number of buses and bicycles using the facility.

Issues raised by cyclists themselves, outside the specific context of this study, largely reflect those considered in planning and design guidance, with the added issue of bus driver training and attitudes.

The importance of bus driver training and attitudes appears to be reinforced by the high proportion of angular crashes at non-intersection locations, which indicates that a substantial proportion of angular crashes is related to lateral movement of buses in the roadway. Such crashes are likely to include ones due to impatience (bus overtaking bike when there is inadequate gap in other traffic), vision blind spots (bus driver cannot see bicycle in rear vision mirrors) and misjudgment of cyclist speed (bus driver under-estimates time and distance needed to overtake bicycle).

This may have been exacerbated in recent times, in the case of scheduled public transport services operated under contract to State governments, by financial penalties for late running being incorporated in contracts.

However, cyclist behaviour and attitudes also contribute to problems and cyclists need to take responsibility for riding responsibly, especially where sharing the roadway with other users. In particular, cyclists need to be more aware of the mode of operation of buses in the roadway, especially limitations on the drivers' ability to see them and on the manoeuvrability of buses.

Where there are no appropriate design solutions, behavioural approaches may still be able to generate improvements.

Specific Issues have been addressed in specific 'Information Notes', which are included as part of this report. These are also available as individual documents, in electronic form, on the website of the Australian Bicycle Council (http://www.abc.dotars.gov.au).

These Information Notes do not replace existing guidelines (for example, the Austroads Guides to Traffic Engineering Practice) but are intended to complement them, to draw attention to issues that may need to be addressed in specific situations and to suggest ways in which they can be resolved or, at least, adverse impacts for cyclists and bus operators and passengers can be minimised. Users should also refer to local State or Territory Guidelines for bicycle facilities.

The information in these Information Notes should be considered in the current review and rewrite of the Austroads *Guide to Traffic Engineering Practice*.

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Buses and Bikes are at opposite ends of the spectrum in terms of size, mass and manoeuvrability but frequently operate in the same road space, especially adjacent to the kerb and at intersections. Both buses and bicycles are effective alternatives to the private car for travel in our towns and cities and are being promoted by governments on this basis, but they can come into conflict as well as working together.

This project seeks to investigate the interaction between buses and bicycles within the road network, and to develop design guidelines and design examples for effective layouts.

Austroads through project management by the Australian Bicycle Council, and the Roads and Traffic Authority, NSW, commissioned ARRB Group Ltd to develop guidelines for the management of interactions between buses and bikes in the road network.

In consultation with the project Steering Committee, ARRB identified a range of key stakeholders from the bicycle and bus sectors from whom information was sought in response to the following questions:

- What are the key issues that arise from interaction between buses and bikes in the road network?
- What options can you suggest for resolving conflicts or adding value to beneficial interaction?
- What standards or guidelines (local, State or national, other than the Austroads Guide to Traffic Engineering Practice Part 14, Bicycles) are you aware of that might apply to these issues?
- Do you wish to nominate any specific situations that might be useful as case studies, including examples of both good and bad practice?

A survey form (Appendix B) was also circulated at the ‘Connecting Cycling’ Conference in Canberra, 20/21 November 2003, and was posted on the Australian Bicycle Council website, http://www.abc.dotars.gov.au/news.htm#nov.

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The information in these Information Notes should be considered in the current review and rewrite of the Austroads *Guide to Traffic Engineering Practice*.

2. SOME BROAD ISSUES

Bicycles and buses represent almost the extremes of the spectrum of users of the travelled-way part of roads in cities, yet they often operate in the same part of the roadway.

Cyclists tend to use the kerbside lane of roads, except where making a vehicular right turn from the centre of the road. Buses also operate primarily in the kerbside lane because of the need to pick-up and drop-off passengers at bus stops.

The cyclist is small and vulnerable; a bus is large and potentially threatening.

The cyclist presents a small visibility profile. The design of buses may mean that the driver has poor visibility with respect to certain areas surrounding the bus, where a cyclist might be located. Although the increasing use of more upright ('mountain bike') styles of bicycle may have enhanced cyclist visibility, recumbent cycles pose particular visibility problems especially in areas alongside large vehicles with high-mounted mirrors – not just buses.

The general perception is that cyclists travel slowly; bus drivers may underestimate the speed of a cyclist being passed and pull in towards the kerb before there is clear space in front of the cyclist to do so.

Both buses and bicycles may have specific parts of a roadway set aside for their specific use (bus lanes and cycle lanes). However, neither of these is necessarily exclusive and conflict can result. Where they are exclusive, the result can be that the other user (often the cyclist) is forced into a more dangerous situation in faster-moving and more complex traffic.

Currently in most jurisdictions, bicycles are permitted to use bus and transit lanes, unless there is a sign prohibiting bicycles. In Victoria and Western Australia, however, bicycles are not permitted in special purpose bus lanes unless signed as permitted. The interaction of buses and bicycles at these locations can cause safety concerns for cyclists and pedestrians and delay to buses (including bus passengers).

Specific issues of visibility and manoeuvrability are likely to occur at intersections, whether or not these include special provision for either bicycles or buses.

The issue of predictability is also important, so that all users of bicycle and bus facilities can have certainty about situations that are likely to arise.

The interaction between bicycles and buses on the road system will have three major types of consequence:

- infrastructure capacity requirements;
- operational performance, in terms of safety, travel times and predictability of level of service; and
- perceptions, particularly by cyclists, that lead to changes in travel behaviour, including mode shift (not using the bicycle) and using alternative routes.

Many of the issues facing cyclists in their interactions with buses in the road network also face them with other motorised road users, especially heavy vehicles. This study, whilst it focuses specifically on buses, may also deliver some benefits in respect of those broader interactions.

3. BUSES AND BIKES IN TRANSPORT STRATEGIES

3.1 Transport Strategies

There is a strong consensus among urban and metropolitan transport strategies that the historical trend of increasing use of the private car for personal travel has to be reversed for a range of reasons, including:

- Congestion
- Local and global (greenhouse) environmental impacts
- Urban sprawl and land use impacts
- Road and transport safety
- Increasing cost of providing and maintaining transport infrastructure and services
- Social inclusion and equity.

Some strategies set targets for reduced car use relative to the ‘business as usual’ expected outcome (eg MTS, 1995; Brisbane, 2003). Others are less quantitatively specific but are equally clear on the direction (eg Government of South Australia, 2003).

Where targets have been set, they have been powerful drivers of new initiatives, in addition to conventional infrastructure and service delivery approaches, such as voluntary travel behaviour change programs (TravelSmart) that have important beneficial impacts on the levels of both cycling and public transport use.

Whilst strategies are based on the need to achieve substantial increases in both cycling and public transport use (as well as other alternatives to the private car), reference to the inter-relationship between cycling and public transport is usually in terms of the bicycle providing a convenient and effective means of expanding the catchment for public transport (trains and buses) through:

- Provision of bicycle parking and secure storage at bus stops and stations, and
- Carriage of bikes on buses.

Both public transport and cycling components have commonly included reference to dedicated facilities (paths, cycle lanes, bus lanes, transit lanes) and other forms of priority (eg at signalised intersections) without recognition of the potential for conflict either:

- Directly between the modes where they share the same space, or
- Between cyclists and general traffic where exclusive bus facilities are established.

The Brisbane Transport Plan, for example, acknowledges ‘linkages’ in terms of *bikes on buses, bike facilities at public transport interchanges and shared road space with bike lanes* (Brisbane, 2003, p14). More specifically, it states (pp40/42) that:

Priority will be given to efficient passenger transport through a network of bus/HOV lanes … The public transport strategy … defines the bus/HOV lane network to support the Busway Strategy and ensure buses are removed from congested lanes on radial roads. HOV lanes for buses and cars with two or more people will also be added to several major arterials to improve the level of service and encourage higher vehicle occupancies (and increase the person-carrying capacity). Transit lanes will also provide priority for emergency vehicles, motorbikes and where possible cyclists.

This could be taken to imply a starting position of exclusion rather than inclusion, with cycle use permitted only where provision for other users is consistent with cycle use. However, the Plan also states (p51) that it aims to *ensure that pedestrian and cyclist planning is integrated with all transport initiatives* including *providing shared bicycle/HOV facilities and shared bus/bicycle facilities on new bus/HOV projects*. Neither the *Plan* nor the associated *Action Plan* provides any detail on how this will be achieved.

In South Australia's *Draft Transport Plan* there is no specific reference to the interaction of buses and bicycles however both modes of transport are identified as being vitally important and have had goals set regarding increasing their use for the range of positive outcomes. This is the only current public domain document that could influence bus/bicycle interaction in South Australia. There will be further action plans as a result of the Transport Plan, however these are yet to be developed.

This is not merely an Australian phenomenon. The *Mayor's Transport Strategy for London* (TfL, 2001), possibly the most comprehensive and radical integrated transport strategy for a major urban area, deals with bikes (section 4j) and buses (section 4f) separately. The *Strategy* (section 4g, *Streets for All*) does state that *measures can be used individually or collectively to support the policies and proposals of the Strategy. Of particular importance is the use of street space allocation to assist road safety initiatives; <u>support bus, pedestrian and cyclist initiatives</u>; and to ensure that initiatives, such as the proposed central London congestion charging scheme, do not result in diverted traffic using unsuitable streets* (current author's emphasis). However, there is no implication that there might be conflict between the bus, pedestrian and cyclist initiatives.

There is often a presumption that buses and business servicing vehicles should have the primary priority, particularly on arterial roads. For example: *The allocation of kerb space to allow for buses, loading and appropriate short term parking is important for both the operation of the business and commercial interests of London and for the efficient running of London's buses. It is therefore vital that each length of kerb space is critically examined, and proposals implemented that take into account all of the competing interests* (TfL, 2001, p199).

3.2 Bicycle Strategies and Plans

The Australian national cycling strategy (Austroads, 1999a) primarily mentions bikes and buses in terms of increasing multi-mode trips involving bicycles and public transport (Strategy 3.4), but does include, without comment, an example of bus-bike co-existence in the roadway.

The UK National Cycling Strategy (DoT, 1996) also focuses on linking bikes and public transport, although it does make specific mention of:

- The potential for traffic management and highway engineering to improve conditions for cyclists, whilst emphasising that *if engineers do not explicitly plan for cyclists, traffic management can make cycling conditions worse, endangering cyclists and discouraging people from cycling* (p15); and

- The need to address traffic engineering, vehicle design and education of drivers to reduce the disproportionate incidence of serious injuries and fatalities caused by crashes with heavy goods vehicles (p17). There is no mention of buses, but the issues raised appear to be applicable to buses as well as heavy goods vehicles.

Not surprisingly, bus-bike interaction is not identified in any other terms in the research requirements to support the UK Strategy (Rosen, 2003).

At a State level, references to buses in bicycle strategies and plans are few and usually in similar terms to the parent transport strategy (see, for example, the WA *Bike Ahead* Strategy (Transport WA, 1996a, p26)).

The recently released *Queensland Cycle Strategy* (Queensland Transport, 2003a) deals with bicycle/public transport issues in the following terms: *Links with public transport can extend the range and usefulness of bicycles, especially for commuting, inter urban trips and tourism. The bicycle can be used at both ends of public transport trips, by being parked at a station or in some circumstances carried with the passenger* (p31).

Regional bicycle network plans generally either do not mention buses and public transport or do so only in the context of cycle access to public transport (see, eg, RTA, 1999; Queensland Transport, 2003b; Transport WA, 1996b; ACT, 1997), in terms of providing routes to access public transport access points, facilities at bus/train stations and/or carriage of bikes on buses. Successful trials of bikes on buses (ABC, 2003) will add weight to the importance of these aspects of bicycle planning.

The New South Wales *Action for Bikes: BikePlan 2010* (RTA, 1999) deals with buses in terms of facilitating inter-modal trips and provision of cycle facilities in conjunction with the proposed Transitways for Sydney. There is no mention of buses and bikes within the road network.

The sole reference to buses in the recently-released New Zealand walking/cycling draft strategy (New Zealand, 2003) is:

Whether it is accessed on foot, by private motor vehicle, in a bus, or on a cycle, all road users share the same road network. Ensuring the network works efficiently for all modes and users - cyclists and pedestrians as well as motor vehicle users – presents a significant, but essential, challenge for those who plan, design, manage and fund the transport system (New Zealand, 2003, p20).

The New Zealand draft strategy does make repeated reference to the potential for cycling to expand public transport catchments, in common with many other strategies. It may break new ground, however, when it states that:

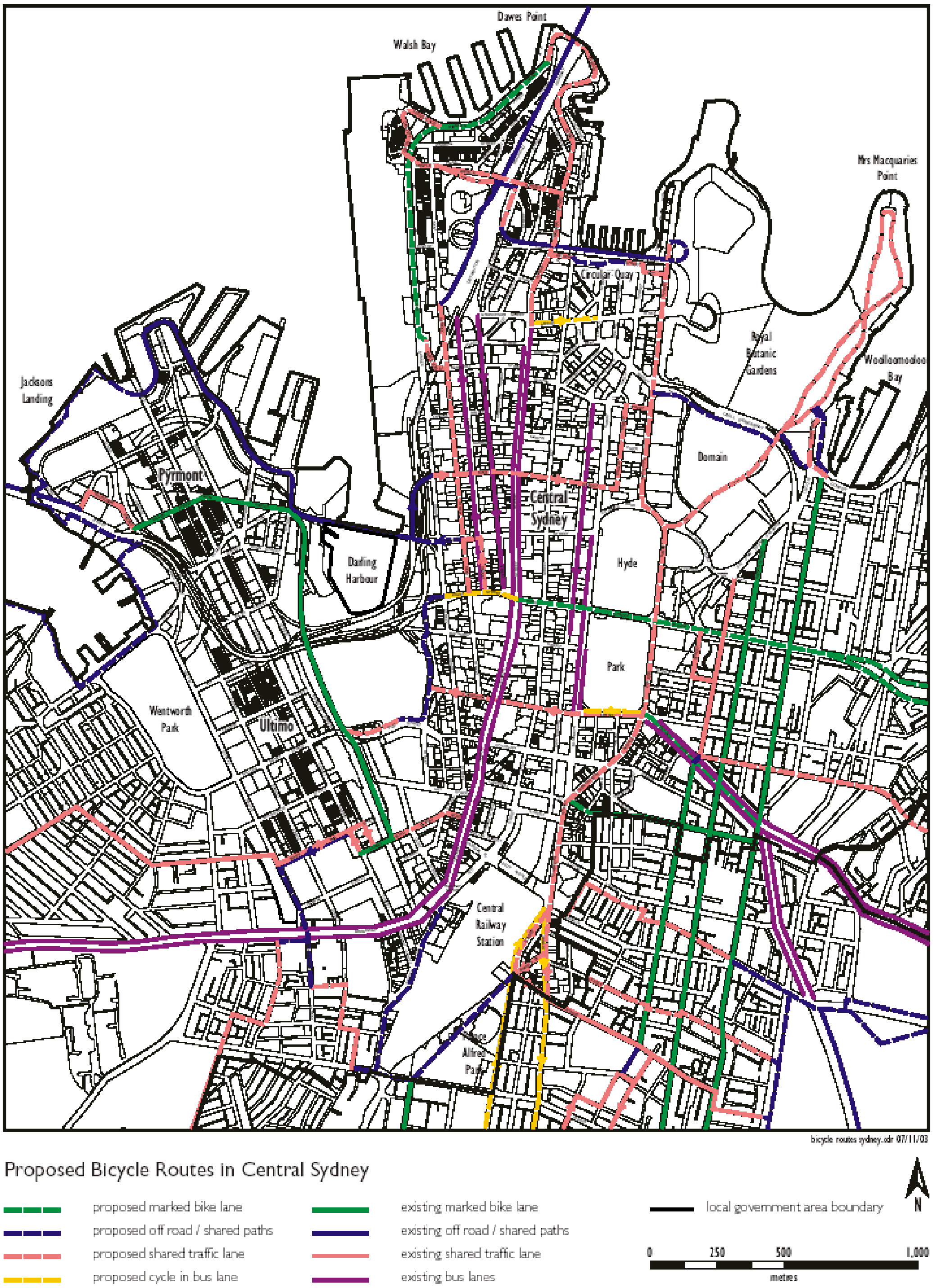
Road environments that are safe for pedestrians and cyclists also benefit public transport users, and tend to be safer for motor vehicle use. In the longer term, it is possible that reduced motor vehicle traffic, resulting from modal shifts to walking, cycling and public transport, could also help improve safety on our roads (New Zealand, 2003, p9).

Many references to buses in bicycle strategies and plans do not specifically relate to the road network but to ancillary facilities such as bus and train stations. However, the UK National Cycling Strategy (1998) does refer to *shared use of the carriageway between cyclists and public transport vehicles can justify better segregated priority access to town centres. Bus and cycle lanes, shared bus/cycle streets and bus/cycle gates are three examples of such priority measures*.

A recent exception, however, is the Central Sydney Bikeplan (Sydney, 2003) which specifically includes bicycle usage of both existing and proposed bus lanes as an integral part of the cycle network (Figure 1). This includes minimum-width bus lanes as well as 1.0m-wide bikelanes delineated within a 4.0-metre bus-bicycle lane, but in other locations alternative routes are designated where the volume and complexity of bus movements may make cycling dangerous.

The City of Brisbane (Novak, 2003) has identified the need to *integrate cycle routes with bus priority projects*.

Figure 1 Central Sydney Bikeplan Routes (Source: Sydney, 2003)



3.3 Public Transport Strategies and Plans

Public transport is less often given the same attention, in terms of separate public planning documentation, as bicycles receive. To a large extent, this is a function of the 'maturity' of the market. As with bicycles, reference to bikes in bus/public transport strategies and plans is usually in similar terms to the parent transport strategy. For example, *Better Public Transport* (Transport WA, 1998) deals with bicycles only in terms of bicycle parking at bus and train stations and the carriage of bikes on buses and trains.

Overseas, the bicycle-related focus of public transport plans has also been on the complementary use of bicycles in conjunction with public transport to expand the range of transport opportunities. The United States Federal Transit Administration (FTA, undated – accessed 27 November 2003) puts it in the following terms:

- ***For Bicyclists.*** *Access to transit allows bicyclists the opportunity to make longer trips. Where physical conditions prevent a continuous bicycle trip, public transportation can provide a link to previously inaccessible destinations.*
- ***For Public Transportation Providers****. Improving bicycle access attracts new transit riders. Bicycle access expands transit's catchment area. Distances to transit stops that may be too far to walk may be within range of a short bicycle trip. Bicyclists represent an important weekend or off-peak market, when transit ridership is typically lower and capacity is underutilized. Providing secure parking for bicycles at transit stops and stations is less expensive than providing parking for automobiles.*
- ***For Livable Communities****. Bicycles and transit provide more mobility options to everyone, particularly those who because of age, disability or income are unable to drive. Less automobile traffic through neighbourhoods contributes to a safer, quieter, and more pleasant environment.*
- ***For Everyone****. Safe and convenient transit service and bicycle facilities attracts more passengers and increases the viability of transit service. Fewer trips by automobile reduces polluting emissions. Increased use of transit and bicycle facilities can decrease traffic congestion.*

4. GUIDELINES AND STANDARDS

4.1 Austroads

Provision for cyclists in the road network is primarily by reference to Austroads *Guide to Traffic Engineering Practice, Part 14, Bicycles* (Austroads, 1999). A parallel guide (*Part 16: On-Road Public Transport*) is currently under development by ARRB Transport Research for Austroads.

Bicycles and public transport are also dealt with in other volumes of the Guide to Traffic Engineering Practice, including:

- *Part 6: Roundabouts*
- *Part 9: Arterial Road Traffic Management*
- *Part 10: Local Area Traffic Management*

4.1.1 Part 14: Bicycles

Part 14, Bicycles, was updated and revised in 1999. The only substantial reference to buses is in respect of bus/bicycle lanes (Austroads, 1999b, p34):

Where the left hand lane of an urban arterial road is a bus lane, it is unreasonable for cyclists to use the normal traffic lane and they should be provided for as follows:

- *in congested city areas where peak period traffic speeds are about 40km/h and space can be made available it may be preferable to provide a 1.5 metre wide bicycle lane to the right of the kerbside bus lane. This would normally result in a combined bus/bicycle lane width of 4.0 – 4.5 metres;*
- *through the sharing of narrow (eg minimal width) bus lanes under very congested conditions. In general this approach is only applicable where buses do not stop in the bus lane; or*
- *where the speed of buses is relatively high (up to say 80km/h) a shared lane 4.5 – 5.0 metres wide is necessary so that cyclists and buses can safely overtake each other within the lane.*

The following factors need to be considered in choosing the most appropriate solution for a route:

- *the preferences of cyclists who use the route;*
- *the speed of buses and other traffic;*
- *the location of bus stops;*
- *the frequency with which buses stop in a length of road; and*
- *the available width.*

Signs erected to legally define the bus lane should also make it clear that cyclists are permitted to use the lane unless this is covered in State or Territory traffic regulations.

For other purposes, buses are not separately identified, despite the differences from other heavy vehicles in terms of operational requirements (eg frequency of stopping at bus stops and exiting/entering the traffic stream) and performance characteristics (eg acceleration; deceleration).

New Zealand developing its own guidelines based on but supplementary to Austroads Part 14. These are expected to be available during 2004.

4.1.2 Part 16: On-Road Public Transport

Part 16, On-Road Public Transport, is currently under development. In its current form, it makes reference to the following bus-bike issues:

- Bicycle and bus lanes
- Bicycle/public transport interfaces
- Mode transfer, including carriage of bikes on buses

It will be possible to ensure referencing of the Bus-Bike Interaction study and the key issues in GTEP Pt 16, with further detailing depending upon the timelines for publication of Part 16 relative to the Bus-Bike study.

Even if timelines preclude full integration, Part 16 could reference the website on which the outputs of the Bus-Bike Interaction study would appear, with any such referencing undertaken in a way that maintains the integrity of the Bus-Bike Interaction toolkit, especially with respect to its being an updatable resource rather than simply a one-off statement.

4.1.3 Part 6: Roundabouts

GTEP Part 6 was published in 1993. It includes a number of references to cyclists, but none specifically to buses. It should be noted that this guide predates the adoption of the ultra-low floor bus as the Australian standard for urban public transport, for which front, centre and rear overhangs have reduced clearances and may, therefore, require wider swept path than earlier high-floor buses (see, for example, VicRoads, 1999). Low floor bus operation at older roundabouts is likely to require greater skill and attention from the driver to the possible detriment of vulnerable users in the roadway.

Part 6 does acknowledge that roundabouts pose an increased risk for cyclists, particularly with respect to crashes with vehicles entering the roundabout, which *needs to be seriously considered when weighing up the benefits and disbenefits of adopting a roundabout treatment at a particular location* (p36). It is important that such 'weighing up' does not systematically disadvantage either cyclists or bus users but is used to develop proposals that benefit (or at least do not disadvantage) both groups.

Part 6 also acknowledges that the existence of roundabouts may affect cyclists route choice on regular journeys. Since the route then chosen was not the cyclist's original preference, it by definition disdvantages the cyclist unless the alternative route is improved at the same time.

4.1.4 Part 9: Arterial Road Traffic Management (Austroads, 1988)

GTEP Part 9 is in the process of being reviewed and updated. Whereas the previous edition made no substantial reference to bicycles, the draft revised version devote a chapter specifically to them. In addition, the chapter on on-road public transport has been enlarged and include a brief section on 'buses and cyclists' which makes reference to this Bus-Bike Interaction study and states:

Buses and cyclists often share the kerbside lane despite the large disparity in size, mass and vulnerability, as this is often considered more appropriate than fostering a situation where cyclists would be required to ride in the traffic lane to the right of the bus lane. In some cases where space is limited and traffic speeds are relatively low (typically in inner city areas or town centres) cyclists are in some cases permitted to use bus lanes. This has been successful in spite of some inconvenience on occasions to both bus drivers and cyclists. However, where space can be made available it is preferable that both buses and bicycles have designated exclusive lanes. Austroads

GTEP Part 14 - Bicycles provides guidelines for lane widths and other design criteria to accommodate both users in the same traffic lane. However, there are no accepted guidelines, and there is very little practice, for accommodating both bus and bicycle lanes in the same roadway, except where the bus lane is located in a median.

Where bus/cyclist sharing of the kerbside lane is not desirable and space is available, consideration should be given to the provision of an exclusive bicycle lane between the bus lane and the kerb, with a separate bicycle lane or shared path for the opposing direction of travel. However, a shared path is only appropriate and likely to be used by commuter cyclists if it provides a reasonable level of service for cycling. Conflict with pedestrians and the number of intersecting driveways and major intersections to be crossed should be minimal.

There is an apparent inconsistency between Part 14 and the draft Part 9, in respect of the suggested location of a bike lane relative to a bus lane, but only in the context of a low traffic speed environment. This could be remedied by including specific reference to low traffic speed environments as below (addition underlined):

Where bus/cyclist sharing of the kerbside lane is not desirable and space is available, consideration should be given to the provision of an exclusive bicycle lane between the bus lane and the kerb <u>or, where traffic speeds are low, to the right of the kerbside bus lane,</u> with a separate bicycle lane or shared path for the opposing direction of travel, depending on circumstances.

4.1.5 Part 10: Local Area Traffic Management

GTEP Part 10 has been reviewed and updated. A final report has been submitted to Austroads, but is not yet a public document. The revised guide clearly states that, in local areas, shared use of roadways by cyclists and other road users is the norm. For example:

The safety and convenience of cyclists and pedestrians in the general traffic system is usually achieved through various ways to segregate them from motor traffic, in time and/or space: separate lanes and paths, signalised crossing points and so on (see Austroads Guide to Traffic Engineering Practice, Parts 13 and 14). However, the free and ubiquitous nature of pedestrian and cyclist movement at the local level means that their total segregation from other traffic is neither desirable nor possible in most cases. Local streets should be attractive and feasible for most pedestrian and cyclist movement, and it is not necessary to provide separately for pedestrians and cyclists in local streets to an excessive manner. Conditions in local streets should therefore cater for the expectation that these different road users may need to share the street space (Section 4.4).

On the other hand:

Unless speeds are quite low (ie <30 km/h) some form of separation for cyclists may be desirable (at least on the designated bicycle network) (Section 4.4).

With regard to buses:

Design templates and guides should be used to ensure that design vehicles, including modern low-floor buses, can pass through or across devices. Consultation with bus and emergency services agencies is a necessary part of the planning and design process (Section 4.5).

Recognising that local area traffic management is not simply a reaction in existing developed areas, but should be an active consideration in planning designing new development:

The essential requirements for network and street designs that meet the speed, safety and amenity requirements (what has been termed "natural traffic calming") are:

1. *A local street network that does not offer paths that are attractive to non-local traffic.*
2. *Local streets that encourage a low-speed environment, without additional speed control devices.*
3. *Avoidance of unprotected or uncontrolled cross-intersections* (Section 4.8).

There is no specific mention of buses in relation to new development.

Bicycles (Section 6.2) and buses (Section 6.4) are dealt with separately, rather than in terms of their interaction, with the exception of the following example (Figure 2:

Figure 2 Combination Hump including Provision for Cyclists

Combination humps such as this example in Copenhagen have flatter ramps for buses straddling more severe plateau ramps for general traffic (Kjemtrup 1988). Note also provision for cyclists to bypass the narrowed section.

4.2 State and Territory Guidelines

Most guidelines for provision of bicycle facilities deal primarily with cycling in the context of roadways and traffic generally without specific reference to interactions between buses and bikes, but there are some examples that deal with the interaction, most commonly with respect to cycle use of kerbside bus lanes. There is no specific mention of non-kerbside (usually median) bus lanes, which would pose particular problems of cycle access and use.

4.2.1 New South Wales

The New South Wales *Bicycle Guidelines* (RTA NSW, 2003, pp27/8) includes material on bicycle lanes and bus lanes, including recommended treatment for bicycle lane by-pass at bus stops. This includes clear specification of bicycle lanes between a bus lane and the kerb as well as shared bus/bicycle lanes.

These guidelines clearly state that ‘bicycles may be ridden in bus lanes but not in “Buses Only” lanes’. The general practice in New South Wales, as reflected in the Central Sydney Bikeplan (Sydney, 2003), is that cyclists are allowed to use kerbside bus lanes, irrespective of lane widths or traffic/bus volumes.

4.2.2 Victoria

VicRoads has produced draft guidelines for bus priority (VicRoads, 2003a) covering:

- Bus lanes
- Set back bus lanes (ie approaching intersections)
- Short bus lanes at traffic signals
- Buses getting out of side streets
- Traffic signal priority for buses.

There is no reference to other road users’ being allowed to use a bus lane.

However, there are three bus/bike lanes in Melbourne. As Melbourne public transport system relies heavily on trams and trains, the need for bus priority infrastructure is somewhat less than what might have been the case for a city of equivalent size. Hence, there is no 'policy' on bikes in bus lanes, but the general practice recognises the dangers to cyclists if they are excluded from bus lanes. It also takes into consideration that the introduction of bus lanes generally results in there being quite a number of cyclists that will then use the route. The results of this are that it emphasises the need for cyclists to be able to use the bus lane legally, regardless of the lane widths.

Similar draft guidelines for bus stops (VicRoads, 2003b) cover the bus-passenger interface and the use of road space at and around bus stops.

However, there is no reference to bicycles in either of these draft guidelines.

Victorian guidelines for ultra-low floor buses (VicRoads, 1999), which are now the urban public transport standard, include some illustrations of how the swept width for such buses (eg at roundabouts and turning at intersections) impacts on the space available for other road users, although cyclists are not specifically mentioned.

4.2.3 Queensland

Queensland Transport (2003c) repeats the Austroads Part 14 guidelines, with some pictorial representation to assist interpretation. This note also deals with cycle lane treatments at bus stops, including the marking of bicycle lanes across indented bus bays and bus stop 'by-passes' for cyclists.

General practice in Queensland is that cyclists are allowed to use bus lanes.

4.2.4 Western Australia

In Western Australia, the issue of bicycle access to bus lanes has achieved a high profile, with the Public Transport Authority favouring the use of 'bus-only' lanes in a number of situations where there appears to be no safe alternative for cyclists. A draft report (McKaskill, 2003) has identified a number of issues that need to be addressed:

- Traffic volumes – and hence the relative safety of the bus lane and residual general traffic lanes for cyclist use
- Traffic speed
- Width of bus lane
- Availability and suitability of 'parallel' cycle routes

The response to this draft report has indicated a need for more quantitative guidelines, especially in view of some situations not being specifically covered by Austroads, Part 14 on bus and bicycle lanes. In the case of Hampton Road, for example, bus speeds are relatively high (around 60km/h) but there is no opportunity to provide additional lane width.

Liveable Neighbourhoods (WAPC, 2000a), which has the objective of providing for *better residential subdivision and structure plans*, identifies the following road types and functions:

- *Primary Distributors* – the regional grid of traffic routes catering for inter- and intra-regional traffic
- *Integrator Arterials* – a finer grain of routes with frequent connections to local streets. Usually bus routes. *Liveable Neighbourhoods* suggests provision of on-street bike lanes or separate shared paths.

- *Neighbourhood Connectors* – streets with predominantly residential frontage that typically provide the lower-order sub-arterial network. These streets service and link neighbourhoods and towns. Could also accommodate public transport. *Liveable Neighbourhoods* suggests provision of on-street bike lanes or separate shared paths.
- *Access Streets* – accommodate shared pedestrian, bike and vehicular movements. The requirements of adjacent land uses should be supported through street design.
- *Laneways* – to provide access to the side or rear of lots principally for access to garages.

For bus routes, *Liveable Neighbourhoods* states:

Buses will normally travel on Neighbourhood Connectors and Integrator Arterials. It is, however, conceivable that they could be routed on some Wider Access Streets which have reasonable length and/or connectivity, ground, beachfront). Where buses are expected to run on a street which would otherwise be an Access Street (without embayed parking) the design of the street should be changed to provide a higher standard of mobility (WAPC, 2000b, p24).

On bus routes, *Liveable Neighbourhoods* recommends against the use of 'too many' roundabouts (WAPC, 2000b, p15) but does not define 'too many'. Its primary concern appears to be passenger comfort (p34) rather than impacts on cyclists or other road users, but elsewhere it does recognise cyclists in specific design issues:

Small diameter roundabouts (approximately 10–12 metre diameter inner island) are common in Perth on bus routes. These appear an appropriate design for NC/NC intersections. Larger radii require substantial land take, involve additional construction cost, and pose added pedestrian and cycle safety problems due to higher vehicle speeds and longer crossing distances.

The Main Roads standard drawing requires a 12 metre diameter inner island for roundabouts on bus routes. Where appropriate a smaller diameter is favoured due to less land requirement and ease of pedestrian and cyclist use. Some Neighbourhood Connectors will, however, be designed with medians and these will require a 12 metre diameter inner island or larger to create the necessary vehicle path deflection through the intersection (WAPC, 2000b, p50).

4.2.5 South Australia

South Australia has eight bus lanes all located within the Adelaide metropolitan area where cyclists are legally permitted to share the lane with buses. As a result of a recent amendment to relevant legislation, taxis are now permitted to also operate in these bus lanes. The bus lanes vary in width depending on the amount of overall road width and the competing demands for road space. Most of these lanes operate during peak hours and are generally available for parking at other times when there is the demand.

There is one bus-only lane that is located within the median that provides high frequency bus access to a sporting stadium and only operates when there is an event at the stadium. Cyclists are not permitted to use this bus-only lane.

There are numerous relatively short bus-only lanes on the approaches to signalised intersections that have bus pre-emption signals to provide buses priority over other traffic. Most of these installations will soon be provided with bicycle lanes and have the bus only lane coloured red so as to make their use easily recognisable for all road users.

South Australia (2000, p8) notes the requirement to give way to a bus that is indicating the intention to rejoin the traffic flow (from a bus bay) when a ‘Give Way to Buses’ sign is displayed. It recommends that cyclists also give way to other buses, such as school buses, in similar circumstances.

4.2.6 New Infrastructure

Most bus-bike interaction within the road network takes place in the context of existing road infrastructure, which has physical limitations and implicit, sometimes explicit, limitations on additional capacity provision. In many places, particularly areas of ‘traditional’ development, there is strong community resistance to road widening and the cost of such widening, including property acquisition, is high. It may also be seen as somewhat contradictory to widen roads in the name of one or more of the green modes of transport.

With new infrastructure, there are often opportunities for providing adequately for all green modes from the start, in both a strategic (network) sense and in design/operation terms, without compromising the function of any of them. For example, in Sydney*, the bike network will include off-road bikepaths including dedicated cycleways next to new infrastructure projects such as the Liverpool to Parramatta rapid bus only transitway as well as on-road cycleways and bike paths that use rail corridors* (Transport NSW, undated, p24). The first of the Sydney Transitways (Liverpool-Parramatta) includes shared cycleway/walkways along the length of the Transitway that are lit and connected to local footpaths (Hart, 2003).

This is a direct parallel to the practice of Main Roads WA of ensuring that separate cycle facilities are provided in conjunction with roads from which cyclists are banned, with the objective of maintaining safety and convenience for both cyclists and motorised road users.

More specifically, new infrastructure can be planned and designed in ways that provides for green modes only. In addition to the NSW transitways, the proposed ‘Green Bridge Link’ for Brisbane, which will connect the University of Queensland St Lucia campus with Brisbane’s southern and eastern suburbs via a new public transport, pedestrian and cycle bridge across the river, will not be available to cars or trucks (Brisbane, 2003).

Figure 3 Provision for Buses and Cyclists in New Infrastructure

Alternatively, new road infrastructure can provide opportunities for enhancing provision for buses and bicycles elsewhere, including removing or ameliorating conflicts between them. In Perth, for example, the construction of the Graham Farmer Freeway (an inner city CBD by-pass) was acknowledged as bringing *the opportunity to realise some long standing community objectives including:*

- *the removal of unnecessary traffic from central Perth;*
- *the improvement of access to destinations in the city;*
- *the creation of a high quality, safe environment for pedestrians;*
- *more accessible, convenient and efficient public transport;*
- *improved access for people with disabilities;*
- *safer, more convenient travel to and through the city for cyclists; and*
- *a better commercial environment for shoppers, retailers and business in general.* (Transport WA, 1997, p1).

4.3 Overseas Guidelines

There is little specific reference to the interaction of buses and bikes in overseas design guidelines, partly for the very reason that the first design response is to separate bicycles from motor vehicles (eg in the Netherlands and Denmark, which are often regarded as world leaders in bicycle planning and provision).

4.3.1 The Netherlands (CROW, 1993)

The basic premise of the Dutch guidelines is separation of bicycle and bus networks and facilities, although with joint use of bus lanes *where volumes of bicycle and bus traffic are low and the function is of subordinate importance*. The guide further states: *The … combination bicycle/bus occurs when a link in a cycling route and a bus route coincide … this does not yet happen often in The Netherlands. They are often relatively short road-sections (200-300m) over bridges or narrow passages (eg a bus-sluice between two residential areas)* (CROW, 1993, p110).

In terms of network planning, the guide clearly sets out the need to assess relative priorities of bus and bike (including level of use and role in network) rather than giving priority to public transport as a matter of course (p60).

To avoid conflicts at bus stops, it recommends that cyclists should be diverted around them – but it also recognises that replaces bus-bike conflict by bike-pedestrian/alighting passenger conflict, so establishes some design parameters that require a width behind the kerb of at least 2.5 metres plus the width of cycle and pedestrian paths.

*4.3.2 **Denmark** (Road Directorate, 2000)*

The *Collection of Cycle Concepts* is described as presenting *an overview, inspiration and motivation regarding bicycle traffic … for general orientation and … as a reference work* (p5). It does not set out specific standards or guidelines, but provides ideas and examples of good and bad practice. It emphasises the importance of intermodality (bicycle in conjunction with other modes), especially the bicycle as a feeder mode for coach, bus, train and plane on longer trips.

With regard to bus-bike interaction, the principal focus is on bicycle parking at bus stops and the design of bus stops and bus bays. Bicycle parking at bus stops can be small-scale and informal (left) or substantial and formal (right), depending on demand (Figure 4).

Figure 4 Bicycle Parking at Bus Stops

Future bicycle parking facilities at bus stops will be covered racks.

The *Collection* states that *the accident risk for cyclists in mixed traffic does in fact rise with the presence of parking bays and bus stops* (p65). Bus bays are seen to avoid head-on collisions (presumably on moving out to pass a stopped bus). Where there is a bike lane at the kerb, *one can establish a bus bay, a short cycle track or a bus-boarder between the cycle lane and the traffic lane* (p70).

The construction of 'cycle tracks' (which in this instance appears to include cycle lanes as well as tracks with kerb separation) *can increase the number of accidents at bus stops unless special safety measures are introduced. … Almost all accidents at bus stops where there is no bus boarder involve alighting passengers and cyclists* (p76). A number of potential treatments are illustrated (Figure 5).

The *Collection* emphasises the potential synergies between bike and bus in the case of 'bus gates' – road closures that allow passage of buses but not other motor vehicles (either through signage or physical barriers). *Bus gates should always be equipped with 1.3-1.4m broad cycle gaps at both sides of the road* (p99).

Figure 5 Bicycle Treatments at Bus Stops (Source: Road Directorate, 2000)

Boarding passengers at bus stops without bus-boarder may stand on the cycle track long before the bus arrives.

Zebra crossings in line of the bus doors improve safety. The profiled marking gives a safer distance between cyclists and bus passengers.

At bus-boarders pedestrians must give way for cyclists in Denmark.

The cycle track is behind the waiting area etc.

Zebra crossings guide bus passengers across the cycle track and accentuate give-way conditions.

Figure 6 Bus Gate with Cycle/Pedestrian Access (Source: Road Directorate, 2000)

Lane width obstruction and cycle gates.

4.3.3 *Ireland (DTO, 1997)*

The Irish national guidelines devote a whole section to 'buses and cycling'. They adopt the fundamental principle that public transport and cycling are both environmentally-friendly modes of transport, and that *where public transport and cycling facilities meet, an integrated design must ensure that neither mode inconveniences the other. The requirements of an integrated design are safety, comfort and directness (neither should be unnecessarily delayed)* (p132). The broad approach is set out in Figure 7, below:

Figure 7 Approaches to Buses and Bikes (Source: DTO, 1997)

Criteria Shape	Function of the road in the network	Volumes (per hour) one direction)	Speed of bus	Parking and other facilities	Implementation room (bus and cycle only) and costs	Remarks
Physical segregation See figure 5.1	Main use is for public transport and cycling.	Frequency = > 20 buses Cycle volumes = > 200	50 - 70 km/h	Parking can be installed between the cycle track and the bus lane.	Width of 5.75m. Will have the highest costs.	Optimum design recommended for all situations.
Visual segregation See figure 5.2	Important use by both public transport and cycling.	Frequency = < 20 buses Cycle volumes = > 100	< 50 km/h	Parking can only be installed on the left-hand side of the on-road cycle track, but this is not recommended. Short stay parking in front of shops must be avoided.	Width of 4.75m.	Can be an alter-native to physical segregation if speed is below 50 km/h
Mixed use of bus lane	Less important use for buses and cycling. Main routes should be planned elsewhere.	Frequency = 10 - 20 buses Cycle volumes = < 100	approx. 30 - 50 km/h	Low level of parking movements allowed alongside the bus route only	Width of 4.25m.	Only applicable on short sections and with low speeds.
Mixed street use (but used predominately by cyclists and buses) one-way or two-ways See figure 5.3a and 5.3b	Predominately used by buses and cyclists. Other motorised traffic is subordinate.	Bus frequency may range from low to high frequencies. The cycle volumes may vary from low to high.	< 30 km/h	Limited parking along the street, but preferably organised in squares and /or garages	Width can be variable: if two-way: 9.30 - 6.50m. if only one-way 6.20 - 4.25m	Due to traffic calming, the quality of life and safety in an area is improved.

The guide sets out recommendations for:

- facilities for buses and cycling on the same roadway
  - physical segregation – generally recommended where bus speed >50km/hr and bus frequency >20/hr (in same direction).
  - visual segregation – generally recommended where bus speed <50km/hr and bus frequency <20/hr (in same direction)
  - shared use of bus lane – generally recommended where bus speed <30km/hr and bus frequency <10/hr (in same direction) and cycle volumes low. However, *in principle, cyclists should always have access to with-flow bus lanes if no other cycle facilities are provided*.
  - contra-flow bus lane with cycle track
  - streets used predominantly by cyclists and buses

  It should be noted that, whereas the Dutch guidelines indicate that visual segregation or shared use only occurs over short lengths of roadway, the Irish ones do not suggest any maximum length of bus lane to which they apply.

- bus lay-bys, bus stops and cycle facilities
  - bus stops with physically segregated cycle facilities
  - bus stops with on-road cycle tracks
  - bus stops on the carriageway
- parking facilities for cyclists near public transport

The guide does not provide strict warrants for volumes or speeds but does suggest thresholds for the various types of treatment. It also includes comprehensive dimension recommendations.

4.4 Regulations

Overseas, bicycles are generally allowed in bus lanes. In the United Kingdom, for example, cyclists are generally allowed to use bus facilities for safety reasons (DETR, 1997), on the basis that pedal cyclists are more likely to be involved in a crash if required to ride in the main traffic lane with buses passing on the kerb-side. However, it acknowledges that where a bus lane is only 3 metres in width, the presence of a cyclist may delay buses and that, where possible, bus lanes should be 4 metres wide.

The Edinburgh Greenways are enhanced bus lanes that include enhanced enforcement and better provision for cyclists and pedestrians. Greenways have been assessed as protecting buses from congestion and improving bus reliability (Buchanan, 2000).

The Australian Road Rules make provision for cyclists to ride in bus lanes only where *(b) information on or with a traffic sign applying to the lane indicates that the driver may drive in the lane or (c) the driver is permitted to drive in the lane under another law of this jurisdiction* (Rule 158(2)). Otherwise, *a driver (except the driver of a public bus) must not drive in a bus lane* (Rule 154(1)).

In the case of cyclists, the same applies to Transit Lanes but motor cycles, taxis or multiple-occupant cars are allowed in Transit Lanes, as of right, subject to specified occupant numbers in the case of cars.

This clearly makes the 'default' option one of excluding cyclists from bus lanes and transit lanes and places the onus on justification of inclusion on a case by case basis. However, several jurisdictions have adopted modified rules for bus lanes.

New South Wales has introduced 'another law of this jurisdiction' (reflecting ARR 158(2)(c)), which specifically states that *a person is permitted to ride a bicycle in a bus lane (other than a bus only lane), tram lane, transit lane or truck lane* (NSW Road Transport (Safety and Traffic Management) (Road Rules) Regulation 1999, Section 15). In effect, in NSW, Rule 154 only applies where the words 'bus only' appear in the sign for a bus lane and the default option is one of inclusion.

Queensland has also introduced regulations (the *Transport Operations (Road Use Management – Road Rules) Regulation 1999*) to clearly state that bicycles are permitted in bus and transit lanes (Queensland Transport 2003c).

In South Australia (2000, p10) cyclists are allowed to ride in bus lanes, but *'when there is a separate signal for buses (a white "B" light) at an intersection, you must allow the bus to proceed on that signal. It is illegal for you to proceed on the white "B" signal'*. There is an inherent conflict between these provisions, as a cyclist may legally be in a bus lane at an intersection, but cannot move through the intersection at the same time as a bus does. In all such situations, in SA, a separate bicycle lane has recently been installed to prevent such conflict.

In Victoria and Western Australia, the Australian Road Rules have not been modified with regard to cyclist use of bus lanes. The WA *Road Traffic Code* also introduces the concept of a 'busway', similar to the NSW Transitway, defined as *a portion of a carriageway that is enclosed in a manner intended to prevent vehicles from moving into that portion of the carriageway other than at the beginning of the portion of carriageway*, from which cyclists are also banned.

The difference between the default options is, however, more fundamental than this apparently semantic distinction might suggest. In NSW, Queensland and South Australia, the legislature has stated that cyclists are legitimate and accepted users of bus lanes. In other jurisdictions, this becomes a matter of operational policy – in WA, for example, the responsibility rests with the Commissioner for Main Roads (Metropolis, 2002).

The practice also differs between those jurisdictions that have not modified the Australian Road Rules version. In Victoria, there are three bus/bike lanes, at least one of which (Johnson Street) is too narrow to allow for buses and bikes to overtake or leapfrog without encroaching into the adjacent traffic lane. In WA, cyclists are not allowed to use bus lanes on Hampton Road (Fremantle) or Canning Highway (Applecross), Dixon Road (Rockingham) or Shepparton Road (Victoria Park). It is also proposed that cyclists not be allowed to use bus lanes currently being constructed on Beaufort Street, Inglewood (McKaskill (2003)[1].

The Hampton Road situation is shown in Figure 8. Traffic volume in this section of Hampton Road is in excess of 20,000 vehicles per day (Main Roads, 2003), with a relatively high truck proportion as the road provides access from the south to the Port of Fremantle. There is no scope for providing additional pavement width within the existing constructed reserve and adjoining properties often have narrow setbacks making widening very difficult.

[1] It is understood that Beaufort Street will now be established and monitored as a trial of bikes in bus lanes in Western Australia.

New Zealand is currently defining road rules for use of special vehicle lanes, drafts of which have stated that bus lanes would be generally accessible to cycles and motorcycles unless specifically precluded. Until this rule is promulgated, usage of bus lanes is governed by local government by-laws, which have generally adopted the same accessible approach to bikes in bus lanes (see, eg, Auckland, 2004).

Among the rules being considered is one stating that a person may not unreasonably impede the movement of a vehicle entitled to use the lane, which could be used to preclude cyclists riding two abreast if this impedes a following bus.

Figure 8 Bus Lane with Single Traffic Lane – Cyclists not Permitted

Photo courtesy of Carey Curtis

5. BUS-BIKE CRASHES[2]

Conflicts between buses and bicycles may result in crashes, but such crashes are relatively infrequent. In Western Australia, there were an average of 12 bus-bike crashes per year (1.5% of total bike crashes) reported to police between 1987 and 1996, inclusive (Hendrie et al, 1998, Table A15). A bus was involved in 1.8% of reported bicycle crashes involving another road user (Hendrie, et al, 2000, Table 2.4).

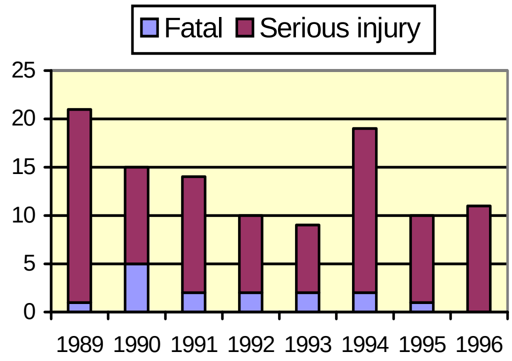
Data on bus-bike crashes are focussed on the fatality and severe injury end of the spectrum. The Australian Land Transport Safety Bureau has provided data on fatal and serious injury bus-bike crashes from 1989 to 1996 (ATSB, 2003), which shows that:

- 1.0% of fatal/serious injury cycle crashes reported to police also involved a bus; and
- 5.6% of fatal/serious injury bus crashes reported to police also involved a cyclist.

This clearly illustrates the high vulnerability of cyclists in a bus-bike crash.

The number of bus-bike crashes resulting in fatality/serious injury varies, Australia-wide, significantly from year to year, as does the proportion of fatality consequences (Figure 2). This is not unexpected in relation to events that occur in small numbers.

Figure 9 Bus-Bike Crashes, 1989-1996: Australia (Source: ATSB, 2003) [N = 109 or 13.6/year]



ATSB (2003) also shows that:

- Fatalities were 1 in 7 personal outcomes from reported bus-bike crashes involving fatality and/or serious injury (Figure 10); and
- Fatalities were most likely to arise from angular or rear-end crashes, with a high proportion also arising in unknown or unclassified situations (Figure 11).

The ATSB data for 1989-1996 also show that:

- 55% of fatalities/serious injuries resulting from reported bus-bike crashes occurred at intersections; and
- 42% of fatalities/serious injuries resulting from reported bus-bike crashes occurred at other locations (Figure 12).

[2] All crash data in this section are based on crashes reported to police. Whilst it is acknowledged that there is substantial under-reporting of cycle crashes, this is least so for fatal and serious injury crashes for which data are available in sufficient detail for the purposes of this study.

Not surprisingly, of the three major types of location, the proportion of angular crashes was highest at X (four-way) intersections. However, there was no difference between the proportions for T-intersections and non-intersection locations (Figure 13).

Figure 10 Fatalities and Serious Injuries in Bus-Bike Crashes, 1989-1996: Australia
(Source: ATSB, 2003) [N = 112 or 14 per year]

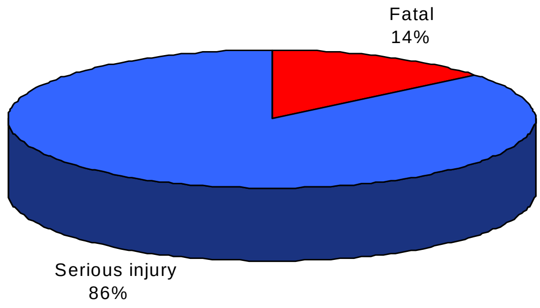


Figure 11 Fatalities and Serious Injuries in Bus-Bike Crashes, 1989-1996: Australia – by type of crash
(Source: ATSB, 2003) [N = 112 or 14 per year]

	Fatal	Severe Injury	Total
Angular	10	59	69
Head-on	0	5	5
Rear end	2	16	18
Struck parked vehicle	0	5	5
Other/Unknown	3	12	15

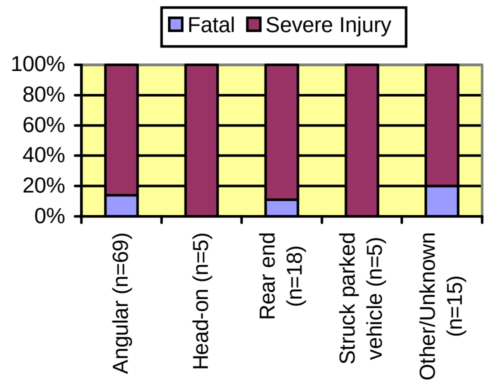


Figure 12 Fatalities and Serious Injuries in Bus-Bike Crashes, 1989-1996: Australia – by location of crash (Source: ATSB, 2003). [N = 112 or 14 per year]

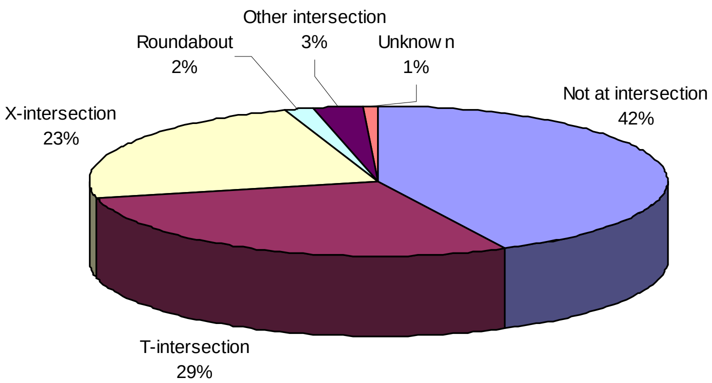
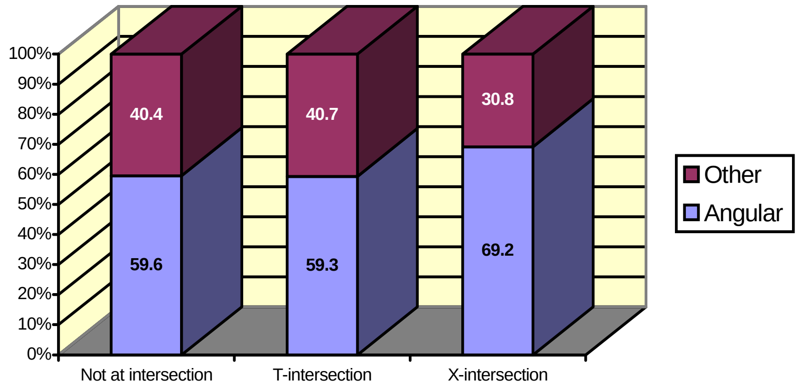


Figure 13 Fatalities and Serious Injuries in Bus-Bike Crashes, 1989-1996: Australia – Crash Type by Location (Source: ATSB, 2003). [N = 105 or 13 per year]



The high proportion of angular crashes at non-intersection locations indicates that a substantial proportion of angular crashes is related to lateral movement of buses in the roadway, although this category would also include crashes where a cyclist rode out from a driveway or path location into the path of a bus. Such crashes are likely to include ones due to impatience (bus overtaking bike when there is inadequate gap in other traffic), vision blind spots (bus driver cannot see bicycle in rear vision mirrors) and misjudgment of cyclist speed (bus driver under-estimates time and distance needed to overtake bicycle).

Studies of bike-bus crashes are relatively old and use data that largely pre-date the widespread introduction of bus lanes and other bus priority measures. It has not been established what impact bus lanes might have had on non-intersection bus-bike crashes, but any study would need also to take into account impacts on other cyclist crashes resulting from the effective separation of bicycles from general traffic.

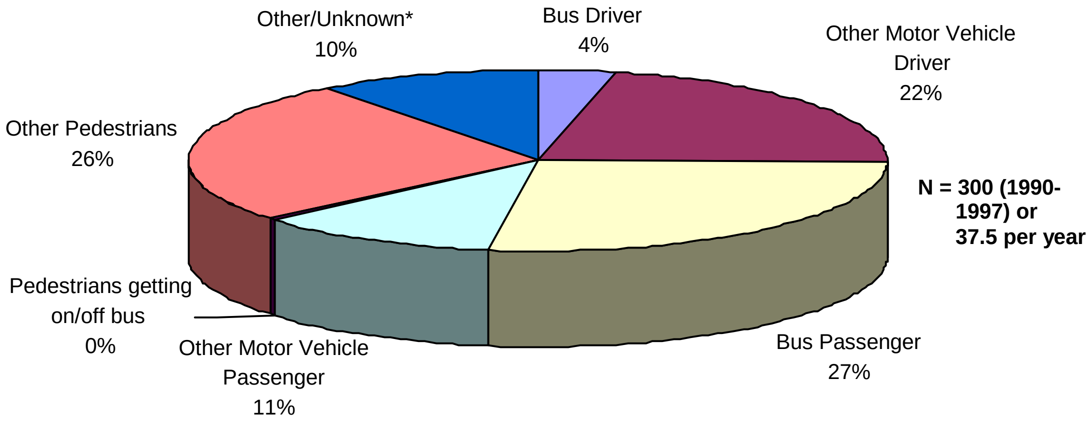
The lack of published data or studies on bus-bike crashes in bus lanes indicates that such crashes have not been identified as a significant issue. The widespread support for and acceptance of cyclist use of bus lanes is further evidence that cyclist safety has not been demonstrated, through practical experience, to be a problem.

Green & Harrison (2002) identified only one bus-bike crash at intersections they studied. This was described in terms of *involving an out of control cyclist on the carriageway trying to avoid side-swiping a bus, which was completing a hook turn* (p34). They concluded that, as this and two other crashes at that intersection (ie 3 of the 5 cyclist crashes) occurred when the cyclist was on the far side of the intersection, *this suggests that signal clearance times may not be sufficient to permit cyclists to traverse the intersection safely before the adjacent direction is legally allowed to move off*.

Signal clearance times for cyclists will be heavily influenced by gradient and should reflect this, especially where green phases may be short and the cyclist may be starting from rest. In the specific case identified by Green and Harrison (2002), the grade is unlikely to be steep, because, by definition, a bus is only required to make a hook turn on a tram route, but the issue of signal clearance times is one that should be addressed at all signalised intersections, with respect to intersecting traffic movements.

Most Australia-wide crash data for buses relates to fatalities. Because fatalities involving buses are relatively uncommon and cyclist fatalities are only a small subset (less than 10%) of them (Figure 14), it is difficult to derive meaningful conclusions from the data.

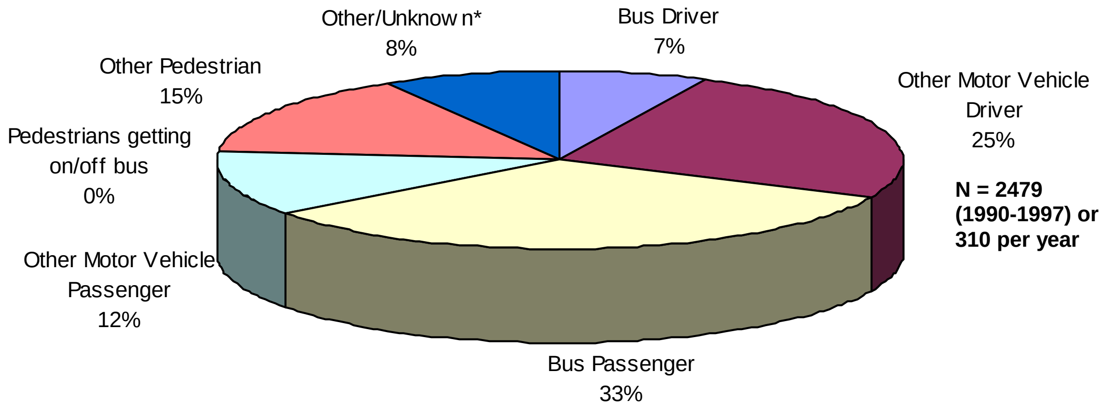
Figure 14 Fatalities resulting from bus crashes by road user, 1990-1997 (Source: ATSB, 2001, Table 10)



* Includes cyclists and motor-cyclists as well as 'unknown'

Bus-bike crashes are an even smaller proportion (<8%) of bus crashes resulting in hospitalisation, although a larger number overall (Figure 15).

Figure 15 Hospitalisations resulting from bus crashes by road user, 1990-1997
(Source: ATSB, 2001, Table 10)



6. ISSUES FOR CYCLISTS

The identification of bus-bike interaction issues for this project is primarily being undertaken on the basis of the consultant's and the Steering Committee's knowledge and experience plus a survey of identified key stakeholders in the bicycle and bus sectors. It is, however, also useful to look at the issues that have previously been document, unprompted, in other forums.

In addition to improving existing situations for cyclists, an important focus for cyclists in relation to public transport has been to ensure that new initiatives to improve the operating environment for public transport do not inadvertently make things worse for cyclists. Of particular concern have been initiatives to provide priority for buses in the road system. As Bicycle Victoria (2003) stated: *it is important that the push for upgraded public transport facilities is not at the expense of cycling* and *the strategy must support and encourage the complementary benefits of integrating cycling and public transport options*.

This implies that if upgraded public transport facilities are overall beneficial to the community, but would make the cyclists position worse, the public transport upgrading should include appropriate mitigation or upgrading measures for cyclists as an integral and necessary part of such a project.

A search of Australian bicycle websites indicated the following issues to be of concern:

- Carriage of bicycles on buses and trains
- Bicycle parking at bus and train stations
- Bus stops and bike lanes
- Bus shelters impeding shared paths
- Use of bus lanes by cyclists
- Criteria for shared bus/bike lanes and for separate facilities
- Bus driver training

The Bicycle Federation of Australia Policy 1997:2, Bicycles on Public Transport (BFA, 1997a), has the objective 'to extend the range and convenience of cycling, public transport authorities permit and in some cases, promote the carrying of bicycles on their public transport services'. However, the policy statements themselves can be seen to apply equally to bus transit infrastructure, such as bus lanes:

1 *All public transport systems shall be designed to be accessible including for cyclists to allow and encourage use of the system by all people and to avoid discrimination.*

2 *Provision of designed facilities on public transport systems will overcome current operational and spatial conflicts and shall be an essential requirement for all new or upgraded public transport infrastructure and services.*

More generally, the BFA states, with respect to bicycles on roads (BFA, 1997b):

1 *Provide adequate operational space for cyclists on all roads and streets to provide an equitable alternative to car travel.*

2 *Where adequate road space cannot be provided either solely or shared, speed limits and road design shall provide adequate operational space to promote cycling, walking and public transport to the benefit of local amenity and environment.*

In the United Kingdom, the Cambridge Cycling Campaign (2001-2003) has documented several issues relating to the development of bus lanes making conditions worse for cyclists and has argued that, in the case of two specific bus lane proposals, *if these two bus lanes were to be installed, any advantages would be outweighed by damage to pedestrian and cycle facilities* (CCC 2001-2003, Newsletter 51).

7. DRIVERS' PERCEPTIONS OF CYCLISTS

Road design and traffic management primarily deal with the objective realities of the road system and of road use. In practice, however, the actual safety and convenience of road use and the safety and related outcomes depend heavily on user perceptions of both the road and traffic conditions and of other users.

In respect of cyclists and motorists, for example, it has been found that there is a significant difference between the attitudes towards cyclists of car drivers who are also cyclists and others who are not (AA, 1993). More recent research suggests that drivers who were also cyclists were *better able to distinguish between different types of cyclists, separating the good from the bad* [but] *on the whole … the attitudes of those who cycled did not vary significantly from those who did not cycle. They tended to see things from the driver's perspective and could be just as negative about cyclists as other drivers who were non-cyclists* (Basford et al, 2002, p12). In general, 'drivers who cycle or have pro-cycling views are less critical of cyclists and drive more considerately, but the differences are not large' (Basford et al, 2002, p18).

When asked to nominate three categories of road users that annoyed them:

- 47% of UK drivers cited taxis;
- 37% cited buses and coaches;
- 30% cited cyclists; and
- 26% nominated vans; and
- 25% nominated trucks.

Only 13% nominated 'cars', which is consistent with a well-established inclination to regard the behaviour of 'out-group members more negatively than the behaviour of 'in-group' members (Basford et al, 2002, pp13/4).

Drivers believe that cyclists are not aware of the fact that their small size can make them difficult to see. Drivers of larger vehicles (heavy trucks and buses) report that this 'tended to infuriate them' (Basford et al, 2002, p7). The same study reports that:

"When prompted, all the professional drivers, regardless of whether they were carrying goods or passengers, tended to be less accepting of cyclists' presence on the roads they were using. They felt that their livelihood was being interfered with – particularly if they were held up by a cycle, which was obviously slower than other vehicles, within their lane. It was reported that being caught behind a cyclist added further to the pressure on their work schedules" (Basford et al, 2002, p7).

In the specific case of scheduled public transport services operated under contract to State governments this pressure may be reinforced by financial penalties associated with late running as part of the contract (eg Perth, Western Australia).

8. KEY ISSUES AND DIRECTIONS

Issues to be addressed were derived from responses from bicycle and bus stakeholders, including responses from attendees at the ‘Connecting Cycling’ conference in Canberra, 20/21 November 2003, and discussions with the project Steering Committee. The issues agreed for inclusion in the ‘Toolkit’ are outlined in Table 1.

Table 1 Issues for inclusion in the Toolkit

Issue	Comment
Strategic and Planning	
Network Planning	Planning of networks for both bus and bicycle can minimise the extent to which potential conflict occurs.
Continuity/consistency of provision for cyclists in bus priority.	Development of a consistent approach to provision for cyclists and to cycle use where priority measures are in place for buses on a route basis. Can include thematic approaches such as London’s ‘Red Routes’ and Edinburgh’s ‘Greenways’.
Cycle audit	Proposal 4J.6 of the *Mayor’s Transport Strategy for London* requires that all new major highway and transport infrastructure and traffic management schemes should be cycle audited.
Road and Facility Design	
Width of Bus Lanes if they are to be shared with cycles	Should they be wide enough for overtaking? Or should this be discouraged? Speed differential and frequent stopping leads to ‘leap-frogging’ or bus delays. Leap-frogging difficult with minimum-width bus lanes and heavy adjacent general traffic.
Separate parallel facilities for buses and cycles	If cycle lane is next to kerb, issues with bus stops, otherwise cycles have traffic on both sides.
Entry and exit points to Bus Lanes	Areas of conflict for cycles.
Intersections	Bus turning movements pose ‘blind-spot’ and ‘swept-path’ issues.
Roundabouts	Roundabout design is a key issue for buses and bicycles independently. The appropriate solutions for one might compromise safety and convenience for the other.
Bus stop design	Bus stop location (esp relative to kerbline) conventionally based on the need for buses to maintain or be able to regain their place in the traffic stream. Need to address cyclist safety and convenience.
Bus shelters impeding shared paths	Location and design of bus shelters has impacts not only on functionality for bus passengers, but also for cyclists who may be legal users of footpaths or shared paths.
Cycle lanes at bus stops	Appropriate treatments for providing ability for cyclists to pass bus at bus stop. Includes ‘bus by-pass’ options
Design of LATM treatments	Must consider needs of both buses and cyclists. Deal with some of the more ‘common elements’ such as speed humps and lateral displacement devices, as well as ‘innovative treatments such as ‘bus gates’.
Trams in kerbside lanes	Proposal for Melbourne – not existing issue. Possible issue for Sydney as light rail develops.
Facility design on hills	Buses are more likely to be held up by cyclists on hills.
Traffic Management	
Cyclist hook turns	Cyclists may take longer to cross an intersection to the ‘hook-turn’ point at the left of the roadway and may not arrive until after the lights for turning/intersecting traffic have turned green.
Cycle use of ‘B’ bus priority lights	Should this be allowed? Can be important where cyclists are allowed to use bus lanes at intersections.

Issue	Comment
Regulations	
Bus Lane provisions can be used to preclude cyclists from ‘bus-only’ lanes.	Issues of relative safety of alternatives (eg bikes in adjacent general traffic lane), width of bus lane and ability to provide safe and convenient alternatives for cyclists.
Contractual imperatives for bus operators	Bus operators under contract to State government or operating under franchise arrangements may be subject to financial penalty for late running. Even without this, there are commercial and customer service imperatives to avoid late-running.
User Behaviour	
Bus driver attitude towards cyclists	How can mutual respect be nurtured?
Young/inexperienced cyclists	How can their safety be improved?
Miscellaneous	
Bus and truck rear view mirrors	These are often at a cyclist’s head height.
Bus fumes	Cyclist is often positioned close to bus exhaust, especially when waiting behind bus in traffic or at bus stop.
Bicycle storage facilities	Availability at bus/bike interchanges.

Two issues were deleted from consideration, on the basis that they were not sufficiently germane to the study, after discussion with the Steering Committee (Table 2). It was noted, also, that ‘bikes on buses’ was currently the subject of extensive trials in Brisbane.

Table 2 Issues not included in the Toolkit

Issue	Comment
Regulations	
Bikes on Buses	Various issues and arguments for and against. Delay to buses; safety issues; design of racks; widens bus catchment; encourages cycling.
Motor cycle use of bus/cycle lanes	Pros and cons. More compatible with bus speeds; may reduce m/c casualties in general traffic lanes.

Issues and directions were workshopped with key stakeholders from both bicycle and bus interests in Perth and Brisbane. To ensure that the views of bus drivers were appropriately acknowledged in the study, a workshop was held with bus drivers in Sydney.

These workshops contributed significantly to the identification and definition of issues and to the understanding of the potential impacts of possible ways of addressing them.

9. CONCLUDING REMARKS

Urban transport strategies for major cities in Australia and overseas focus heavily on reducing , or at least reducing the growth in, car traffic, for a range of social, environmental and economic reasons. A reasonable presumption for the green modes of transport (walking, cycling and public transport), therefore, is that one should not be given priority at the expense of another, and that where a project may have this effect it should be redefined to ameliorate the adverse impact or provide an appropriate alternative.

At the strategic planning level, the interaction of bikes and buses is most frequently seen in terms of the potential of the bicycle, as a feeder mode, to expand the catchments for public transport, although the emphasis has most often been on train stations rather than tram or bus stops.

In terms of planning and design guidance, most attention has been paid to the co-existence of bikes and buses in transit along the roadway. Key issues in this respect include:

- the extent of separation (if any) between bikes and buses; and
- treatment at bus stops – with respect to bikes passing buses and potential conflict with boarding/alighting passengers.

Where there is no physical separation of bus and bicycle facilities, the general practice is to allow bicycles to use a bus lane. Western Australia appears to be a sole exception, with its current practice at odds with that adopted either formally (through regulation) or informally (through the way in which regulations are applied) in other Australia jurisdictions and overseas.

Whilst the Dutch guidelines indicate that shared use only occurs over short lengths of roadway, others do not suggest any maximum length of bus lane to which they apply. This is important given that the likelihood of a bus being delayed by a cyclist will, other things being equal, increase with the distance for which the facility is shared, as well as the number of buses and bicycles using the facility.

Issues raised by cyclists themselves, outside the specific context of this study, largely reflect those considered in planning and design guidance, with the added issue of bus driver training and attitudes.

The importance of bus driver training and attitudes appears to be reinforced by the high proportion of angular crashes at non-intersection locations, which indicates that a substantial proportion of angular crashes is related to lateral movement of buses in the roadway. Such crashes are likely to include ones due to impatience (bus overtaking bike when there is inadequate gap in other traffic), vision blind spots (bus driver cannot see bicycle in rear vision mirrors) and misjudgment of cyclist speed (bus driver under-estimates time and distance needed to overtake bicycle).

This may have been exacerbated in recent times, in the case of scheduled public transport services operated under contract to State governments, by financial penalties for late running being incorporated in contracts.

However, cyclist behaviour and attitudes also contribute to problems and cyclists need to take responsibility for riding responsibly, especially where sharing the roadway with other users. In particular, cyclists need to be more aware of the mode of operation of buses in the roadway, especially limitations on the drivers' ability to see them and on the manoeuvrability of buses.

Where there are no appropriate design solutions, behavioural approaches may still be able to generate improvements.

10. DEVELOPING THE TOOLKIT

10.1 Issues and Options

The issues outlined in the preceding section were further developed to identify the key elements of the issue, the proposed solution(s) and best practice from Australia and overseas. Issues under the headings ‘Strategic and Planning’, ‘Road and Facility Design’ and ‘Traffic Management’ (Sections 3.2, 3.3 and 3.4) were documented in *Guidelines* and the remaining issues (‘Regulations’, User Behaviour’ and ‘Miscellaneous’) as *Information Notes*.

The remainder of this report, other than the specification for the toolkit itself, is in the form of these Guidelines and Information Notes.

10.2 Outline Specification for Toolkit

The stated objective for the bus-bike interaction project is the development of a ‘toolkit for practitioners of best practice resources, guidelines and typical traffic designs that will be placed on the ABC website’.

The principal criteria for the toolkit included:

- Accessibility, including speed of access, recognising that many people do not have high-speed modems;
- Legibility of structure;
- Simplicity and usability in both hard-copy and electronic formats.

The toolkit structure is based on the following:

- A ‘front-end’ that is the table of contents, with hyperlinks to component documents, and including link to free download of Acrobat Reader for those who do not already have this application installed on their computers.
- Documents in Acrobat .pdf format, downloadable individually. PDF files have a number of advantages over HTML, particularly in terms of:
  - predictable printing – what you see is what you get, whereas HTML can present and print differently depending on computer, browser and printer set-up
  - ease of updating – conversion to .pdf is very straightforward, so source documents can be held in amendable form (such as MS WORD) and reconverted after updating
- Whole toolkit (including title/contents page) also downloadable as a single .pdf file.
- An individual paper (‘Guideline’ or ‘Information Note’ as appropriate) for each issue agreed by the Steering Committee.
- Maximum four A4 pages per issue/document with a standard presentation style and format (see over). This facilitates production of hard copy versions if desired (eg for handing out at conferences) and creates an overall image that promotes recognition.
- Expandable in terms of the number of issues included in the toolkit – achieved by having a simple document format and structure, with the main linkages being via a single contents page.
- Adaptable to provide a similar ‘feel’ to other policy and guideline documents of the ABC, especially those that lend themselves to ‘part’ formats.

The structure of the toolkit is illustrated in Figure 16, with initial entry being via the Australian Bicycle Council website. Other websites (such as those of bicycle user groups), shown as ‘third party websites', are also likely to want to have direct linkage to the toolkit. This will enhance the value and accessibility of the toolkit and the information contained in it.

Figure 16 Structure of the Toolkit

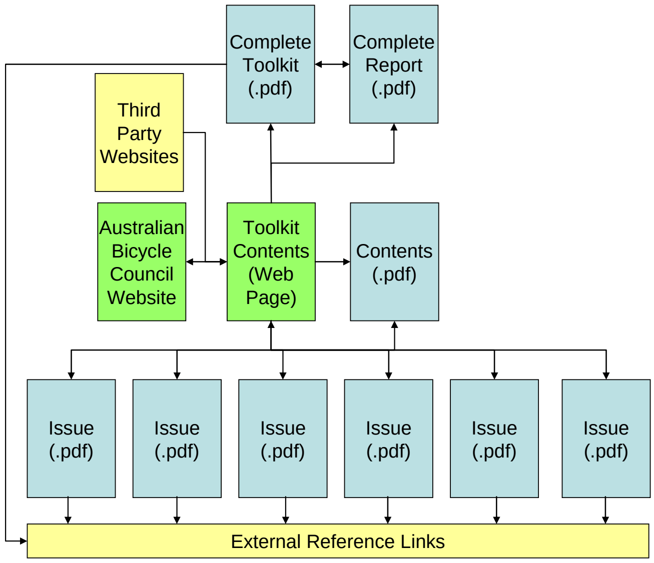
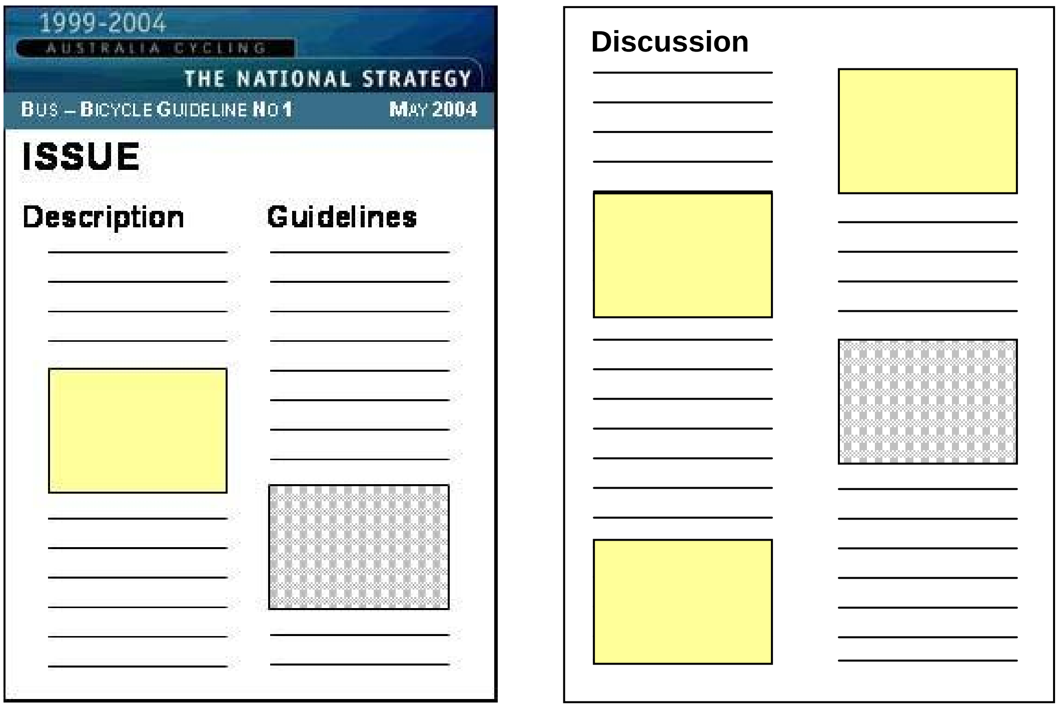


Figure 17 illustrates the type of format that would be used for the individual documents (illustrative only). Any subsequent pages would be similar to that shown on the right, but we would work on the basis of two pages (double-sided) except where there is substantial reason for greater length.

Figure 17 Illustrative Format for Toolkit Guidelines and Information Notes



11. THE TOOLKIT

This section presents the components of the Toolkit. It comprises:

- An Overview of bus-bike interaction within the road network
- Table of Contents, with links to individual Guidelines or Information Notes, including a brief outline of the issue addressed therein
- Individual Guidelines and Information Notes

Each Guideline or Information Note has the same structure:

- Description/definition of the issue
- Recommended Approach – how to address the issue
- Discussion – basis for 'recommended approach' and matters to look out for in practice.

Pagination in the Guidelines and Information Notes that follow may differ slightly from that in the toolkit documents themselves.

It should be noted that these Guidelines and Information Notes do not replace existing guidelines (for example, the Austroads Guides to Traffic Engineering Practice) but are intended to complement them, to draw attention to issues that may need to be addressed in specific situations and to suggest ways in which they can be resolved or, at least, adverse impacts for cyclists and bus operators and passengers can be minimised.

OVERVIEW

Buses and Bikes are at opposite ends of the spectrum in terms of size, mass and manoeuvrability but frequently operate in the same road space, especially adjacent to the kerb and at intersections. Both buses and bicycles are effective alternatives to the private car for travel in our towns and cities and are being promoted by governments on this basis, but they can come into conflict as well as working together.

Urban transport strategies for major cities in Australia and overseas focus heavily on reducing, or at least reducing the growth in, car traffic, for a range of social, environmental and economic reasons. A reasonable presumption for the green modes of transport (walking, cycling and public transport), therefore, is that one should not be given priority at the expense of another, and that where a project may have this effect it should be redefined to ameliorate the adverse impact or provide an appropriate alternative.

At the strategic planning level, the interaction of bikes and buses is most frequently seen in terms of the potential of the bicycle, as a feeder mode, to expand the catchments for public transport, although the emphasis has most often been on train stations rather than tram or bus stops.

In terms of planning and design guidance, most attention has been paid to the co-existence of bikes and buses in transit along the roadway. Key issues in this respect include:

- the extent of separation (if any) between bikes and buses; and
- treatment at bus stops – with respect to bikes passing buses and potential conflict with boarding/alighting passengers.

Where there is no physical separation of bus and bicycle facilities, the general practice is to allow bicycles to use a bus lane. Western Australia appears to be the principal exception, with its current general practice at odds with that adopted either formally (through regulation) or informally (through the way in which regulations are applied) in other Australia jurisdictions and overseas.

Whilst Dutch guidelines indicate that shared use only occurs over short lengths of roadway, others do not suggest any maximum length of bus lane to which they apply. This is important given that the likelihood of a bus being delayed by a cyclist will, other things being equal, increase with the distance for which the facility is shared, as well as the number of buses and bicycles using the facility.

Issues raised by cyclists themselves, outside the specific context of this study, largely reflect those considered in planning and design guidance, with the added issue of bus driver training and attitudes.

The importance of bus driver training and attitudes appears to be reinforced by the high proportion of angular crashes at non-intersection locations, which indicates that a substantial proportion of angular crashes is related to lateral movement of buses in the roadway. Such crashes are likely to include ones due to impatience (bus overtaking bike when there is inadequate gap in other traffic), vision blind spots (bus driver cannot see bicycle in rear vision mirrors) and misjudgement of cyclist speed (bus driver under-estimates time and distance needed to overtake bicycle).

This may have been exacerbated in recent times, in the case of scheduled public transport services operated under contract to State governments, by financial penalties for late running being incorporated in contracts, although, in any case, journey times and reliability for passengers are legitimate concerns for public transport providers.

Cyclists also need to be more aware of the mode of operation of buses in the roadway, especially limitations on the drivers' ability to see them and on the manoeuvrability of buses.

The issues included in the Toolkit are listed in the next document. If you are viewing this electronically, as a single document, or using a web browser, the contents list is hyperlinked to take you directly to the individual guidelines or information sheets.

Bus-Bike Interaction Within The Road Network

Information Notes February 2005

AUSTROADS

CONTENTS

1. **Network Planning**	*Most cycling and most bus services utilise the surface road system, which is essentially a common-user system, although within it parts of individual road carriageways may be set aside for the exclusive use of one or more classes of users (eg bike lanes and bus lanes). Conflicts between users can degrade the cycling experience at specific locations which, in turn, may reduce the attractiveness of cycling over a range of areas and routes of which such locations form part. Planning of networks, for both bike and bus, can provide an opportunity to minimise such conflicts*
2. **Continuity and Consistency**	*Continual changing of conditions for cyclists and other road users along a route fosters uncertainty and unpredictable behaviour, particularly at those places where conditions change, and will act as both real and perceived barriers to use by cyclists. Such change points are likely to be hazardous in themselves, especially where sub-optimal treatments are imposed by, for example, road-space constraints and high traffic volumes.*
3. **Cycle Audit**	*Public transport infrastructure and traffic management measures that assist public transport can have negative impacts on cycling in many different ways, causing cyclists delays, inconvenience and increased risk of crashes. There is currently no systematic process applied nationally to ensure that before measures to promote and assist public transport are introduced, steps are taken to overcome adverse cycling impacts and, where possible, improve cycling facilities.*
4. **Shared Bus-Bike Lanes**	*The inherent speed differential between these modes, and the frequent stopping of buses, often leads to 'leap-frogging' or bus delays. Such leap-frogging is difficult with minimum-width bus lanes and heavy adjacent general traffic. The issue is, therefore, should shared bus & cycle lanes be wide enough for overtaking, or should this be discouraged?*
5. **Separate Bus and Bike Lanes**	*When parallel bus and cycle lanes are provided, both within the road space, they may be either physically or visually separated, and either one may be located adjacent the kerb. However, if the cycle lane is next to the kerb, there will be increased issues with bus stop conflicts. On the other hand, if the bus lane is next to the kerb, cyclists will have traffic on both sides.*
6. **Bus Station Entry/Exit**	*The entry and exit points for bus stations inevitably have high concentrations of bus movements often in complex environments involving turning and other vehicle manoeuvres.*
7. **Bus Left Turn at Intersections**	*Bus turning movements can pose 'blind-spot' and 'swept-path' issues, especially where the bus is making a left turn from a dedicated left-turn lane and lane geometry is inadequate for the bus to remain totally within the turning lane. This especially important for cyclists travelling straight through the intersection as they will usually be close to the left of this lane, immediately to the right of the left-turn lane.*
8. **Roundabouts**	*Roundabout design is a key issue for buses and bicycles both in the context of their interaction, and individually. The appropriate solutions for one might compromise safety and convenience for the other. The issues may also vary depending on the size of the roundabout, i.e. those with only a single circulating lane compared to those with two or more.*

9. Bus Stop – No Cycle Lane	*One of the most regular and difficult interactions between buses and cyclists occurs at bus stops. When a bus is approaching a kerbside stop the driver may have to decide whether to overtake a cyclist and then pull to the kerb in front of it, or to slow down and wait for the cyclist to clear the bus stop. In the first instance, the cyclist then has to decide how to manoeuvre around the stopped bus. The options are usually either to overtake, by merging into the general traffic lane, or to wait for the bus to pull away. Alternatively, they may attempt to ride between the bus and the kerb, where a conflict often occurs with passengers boarding or alighting from the bus.*
10. Cycle Lanes at Bus Stops	*The issue here is fundamentally the same as that for Guideline 9, Bus Stops (No Cycle Lane), but is exacerbated by the bus always being positioned further out from the kerb on the approach to the bus stop.* *When a bus is approaching a kerbside stop the driver may have to decide whether to overtake a cyclist and then pull to the kerb in front of it, or to slow down and wait for the cyclist to clear the bus stop. In the first instance, the cyclist then has to decide how to manoeuvre around the stopped bus. The options are usually either to overtake, by merging into the general traffic lane, or to wait for the bus to pull away. Alternatively, they may attempt to ride between the bus and the kerb, where a conflict often occurs with passengers boarding or alighting from the bus.*
11. Bus Shelters Impeding Shared Paths	*Bus shelters that intrude on the travel space of cyclists on shared paths, either directly (ie encroaching on the path itself) or indirectly (reducing lateral clearances) will reduce the safety, convenience and comfort of the facility for cyclists. Bus shelters are increasingly used for commercial advertising, which requires exposure to passing traffic, rather than having as its primary function serving the needs of bus users. Even where no shelter is present, bus stop furniture (posts, seats, etc) may intrude on the travel space for cyclists.*
12. Local Area Traffic Management	*Local Area Traffic Management (LATM) involves modifications to the structure, layout or design of local streets, with the primary objective of reducing the adverse amenity impacts of car traffic in residential areas. Such modifications can have adverse impacts on the suitability of the street for bicycle and bus use unless facilities are appropriately designed.*
13. Trams in Kerbside Lanes	*Whilst not specifically an interaction between* ***Buses*** *and cycles, in a similar vein, tram tracks in the kerbside lane are incompatible with the safe and convenient operation of bicycles. Tram lines in the roadway are a hazard for cyclists where they cannot be crossed at something approaching a right-angle. Trams in the kerbside lane would leave only a narrow piece of road (600-750mm) between the track and the kerb, effectively precluding cyclists from moving out of this area, either to pass a tram (or other vehicle) or to make a right-hand turn.*
14. Facility Design on Hills	*Other things being equal, cyclists will travel more slowly on uphill grades and be more likely to be encountered by a bus seeking to pass. Cyclists will be less likely to be impeded by a bus.* *Conversely, downhill grades will decrease the frequency with which a bus encounters a cyclist and increase the frequency with which a cyclist may be impeded by a bus (usually at a bus stop).*
15. Hook Turns	*Cyclists may take longer to cross an intersection to the 'hook-turn' point at the left of the roadway and may not arrive until after the lights for turning/intersecting traffic have turned green.* *Where bus priority signals are in operation on the intersecting road, a bus driver may be unaware of a cyclist still in the intersection as the bus has been given a clear signal of priority.*
16. Cycle Use of 'B' Bus Priority Lights	*Bus priority lights are usually approached by a bus lane (which may be used by cyclists), but regulations state that only buses can move when the signal is illuminated. Bus priority lights can be used to authorise movements not permitted to other vehicles, as well as to give priority timing.*

17. New Bus Facilities	*New, dedicated, bus facilities in exclusive rights of way, provide opportunities for creating new cycle and pedestrian facilities and movement opportunities along the same alignment. As well as enhancing the route options available to cyclists and pedestrians, such facilities also improve the accessibility of bus stops and stations along the route, potentially increasing bus patronage especially if bicycle parking is also provided and enhancing the accessibility of locations along the route.* *However, such facilities may also increase severance and reduce the convenience of cycling if adequate crossing opportunities are not provided.*
18. Bus Lane Regulations	*Potential conflicts between bicycles and other vehicles are likely to be less in bus lanes than in adjacent general traffic lanes. However, cyclists operate more slowly than buses and may delay buses in a priority facility. There may not be safe and convenient alternative routes for cyclists.*
19. Contractual and Commercial Imperatives	*Bus operators under contract to State government or operating under franchise arrangements may be subject to financial penalty for late running. Even without this, there is a commercial and customer service 'imperative' to avoid late-running wherever possible. Cyclists are seen as slow-moving and likely to hold-up buses, especially where there is little requirement for buses to stop to pick-up or drop-off passengers along the bus lane.*
20. Bus Driver and Cyclist Attitudes and Behaviour	*Bus drivers are specifically trained for their job and spend a large amount of time on the road. Nevertheless, cyclists can feel unsafe in close proximity to buses, especially when the bus is driven too close or too fast for comfort. Uncaring or unknowing behaviour by drivers towards cyclists adversely affects cyclist safety. Equally, irresponsible or unpredictable behaviour by cyclists adversely affects their own safety but also creates potential hostility from other road users, including bus drivers. Although behaviour is influenced by attitudes, it is not the only determinant; poor attitudes primarily result in dangerous behaviour where buses and bikes come into conflict through having to share the same space.*
21. Young or Inexperienced Cyclists	*Young and/or inexperienced cyclists are least able to cope with complex traffic environments. They are likely to travel more slowly, be less predictable than more experienced cyclists and more likely to be unsettled by the close proximity of large and/or fast vehicles. They are, therefore, more at risk of coming into conflict with other road users and more likely to be perceived as an impediment to buses, in particular.*
22. Bus Rear View Mirrors	*External rear view mirrors on buses may be at cyclists' head height. This may pose a hazard for cyclists when operating in close proximity to buses.*
23. Bus Exhaust Fumes	*Poorly-maintained buses may emit large quantities of exhaust emissions, especially particulates, in stop-start operation including where cyclists may be required to wait behind a bus (at signals or bus stops) because no passing opportunities are available.*
24. Bicycle Storage Facilities	*Bicycle storage facilities are a key element in fostering a complementary relationship between cycling and public transport, to the benefits of both. Secure bicycle parking has been more heavily promoted with rail public transport than with bus, at least in Australia, and there are few examples of bicycle parking at regular bus stops.*

NETWORK PLANNING

Issue

Most cycling and most bus services utilise the surface road system, which is essentially a common-user system, although within it parts of individual road carriageways may be set aside for the exclusive use of one or more classes of users (eg bike lanes and bus lanes). Conflicts between users can degrade the cycling experience and/or the bus user experience at specific locations which, in turn, may reduce the attractiveness of cycling or public transport over a range of areas and routes of which such locations form part. Planning of networks, for both bike and bus, can provide an opportunity to minimise such conflicts.

Recommended Approach

For many types of cyclists, the coincidence of cycle and major bus networks should be kept to a minimum, unless it is possible to provide visually- or physically-separated facilities for cyclists. This is especially important for inexperienced and young cyclists. The alternative routes for cyclists should offer a higher level of service, including consideration of distance, than the one rejected on the grounds of sharing with buses.

Where sharing by bus and bicycle is not considered desirable, consideration should be given to changing bus routes as well – not just cycle routes – in the context of an integrated local and regional approach.

For experienced and commuter cyclists, however, arterial roads, which often carry a substantial number of buses, form logical and convenient cycle routes. Planning for buses should be undertaken bearing in mind the need also to provide arterial routes for cyclists.

The cycle network, including any alternatives to major arterials and bus routes, should still meet the principal network planning requirements of convenience; accessibility and safety; comprehensive coverage; connectivity; and regional coverage.

This approach requires, wherever possible, knowledge of planned bus route networks, especially where priority for buses (bus lanes; traffic signal priority) is proposed, so that bus and bicycle networks can be planned to minimise conflict and maximise synergies (eg by ensuring good cycle access to public transport stops/stations with bicycle parking facilities).

Where bus priority facilities or intensification of bus services are being considered for a road that forms part of an existing or planned designated bicycle network, the bus proponent[1] should have the responsibility to ensure that the appropriate level of service is maintained for cyclists, either on the same route or an alternative route. See also Information Note No 3, *Cycle Audit*.

In the case of new, dedicated, bus facilities in exclusive rights of way, consideration should also be given to creating new cycle and pedestrian facilities and movement opportunities along the same alignment.

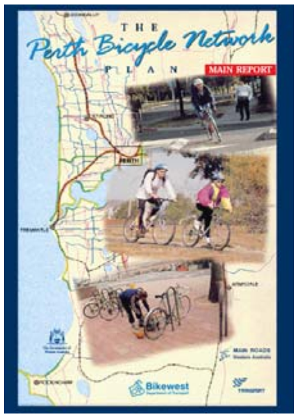
Discussion

In simple terms, a cycle network is a coherent system of cycle routes which connect relevant places and are planned for a high level of safety and service (Road Directorate, 2000). The objective of bicycle network planning is to *provide a comprehensive network that will suit the desire lines* [origin-destination patterns] *of cyclists by connecting common origins and destinations of trips* (Austroads, 1999, p6).

The principles of bicycle network planning are described in CROW (1993, Ch 3) and Austroads (1999, Ch 2).

The requirements for a cycle network have been encapsulated, in an Australian context, in the concept of the 4-Cs in the *Perth Bicycle Network Plan* (Transport WA, 1996, p2):

- is **C**onvenient, accessible and safe
- is **C**omprehensive, providing access to most destinations for most cyclists
- establishes **C**onnectivity
- has regional **C**overage



[1] Infrastructure or service improvements may be the responsibility of a range of organizations, including State and local governments and private bus service providers.

Similar concepts and criteria have been established in The Netherlands (Coherence, Directness, Attractiveness, Safety and Comfort – CROW, 1993, pp44/5) and Denmark (Accessible and coherent; Direct and easy; Safe and secure; Self-explanatory design; Comfortable and attractive – Road Directorate, 2000, pp48-51).

Good bicycle network planning will also respond to the five basic requirements for cyclists identified by Austroads (1999, Chapter 3):

- for cyclists Space to ride – respecting the 'operating envelope', most notably clearance from fixed objects or moving vehicles;
- A smooth surface – cyclists are highly sensitive to both macro and micro imperfections in the riding surface;
- Speed maintenance – the greatest effort is required by cyclists when regaining desired speed after stopping or slowing;
- Connectivity – avoidance of interruptions to route options for cyclists; and
- Information – including distance and destination signing.

Good bicycle planning will consider, at an early stage, the suitability of existing roads and other facilities to be incorporated in the network, but there will be occasions where the interests of various road users come into conflict. In such circumstances, the interests of the various road user groups must be weighed up to establish the best overall solution. CROW (1993) describes this 'weighing up' in the following terms:

- *Alternative alignments* – generally a longer route that can be upgraded to provide a higher level of service for cyclists, including consideration of the additional travel distance involved.

  According to CROW (1993, p49), studies have shown that 50% of cyclists will not use a route that is more than 6% longer (distance) or 5% longer (time) than the shortest route. However, other characteristics, such as a more scenic route or less conflict with traffic, may compensate for longer distances.

  Where alternative routes are being considered for cyclists, routes that are more than 6% longer (for overall journeys) would need to be justified in terms of other compensating factors beneficial to cyclists.

- *Financial considerations* – what is achievable within the financial resources available, which may affect the planning of the network (eg spacing of routes), the standard of the network (eg types of facilities) and/or the staging of network development over a period of years.
- *Motor-vehicle network versus cycling network*. This is a fundamental issue for cycle network planning and requires consideration of:
  - o the function of the cycle route (through, distributor or access)
  - o the extent to which the facility solves a bottle-neck problem and improves the quality of the network
  - o the consequences of not building the facility.
- *Public transport network versus cycling network*. Buses are often given priority almost as a matter of course, but it is important to make a comparative assessment of the impacts of bus-priority, cycle priority and equal priority. Factors such as volume of use, role in the network, impact of delays due to lack of priority and the adequacy of alternative routes should be taken into account.

Cycle network planning also needs to take into account the types and capabilities of cyclists. Austroads (1999, pp4/5) identifies seven different categories of cyclists[2]:

- Primary school children
- Secondary school children
- Recreational cyclists
- Commuter cyclists
- Utility cyclists
- Touring cyclists and
- Sports cyclists in training

The skill levels and ability to cope with complex traffic environments varies greatly, being lowest for primary school children and highest for commuters, sporting cyclists and some touring cyclists. Cycle trips are likely to be shortest for primary school children and utility cyclists, for whom arterial roads, where the concentration of buses will generally be greatest, are least likely to offer convenient routes. The desirability of separating cyclists from buses will depend upon:

- The skill levels of cyclists
- The cycle journey purposes
- The concentration of buses and cyclists

In the Netherlands, planning of both bus and cycle networks is based on the separation of the two, with coincidence of location largely being confined to short road sections over bridges or other narrow passages (eg bus sluice between two residential areas) (CROW, 1993, p110). CROW suggests a structured approach to separating bus and bicycle traffic based on the relative function of bus and bicycle routes:

Cycle Function / Bus Function	Through (arterial) Cycle Route	Distributor Cycle Route	Access Cycle Route
Connecting (arterial) Bus Route	Separating	Separating or mixing, depending on volumes	Separating or mixing, depending on volumes
Access Bus Route	Separating	Mixing	Mixing

Networks are not static entities and the level of cyclist service may be compromised by works undertaken in

[2] There are other possible categories of cyclists (eg bicycle couriers) and there will be varying levels of skill and ability <u>within</u> the Austroads categories (eg utility cyclists may also be commuter cyclists at other times).

the interests of other road users after the cycle network has been planned or established. The impact of such works on cycle networks should be required to be assessed in the planning and justification process for those works.

In the United States, the Transportation Equity Act for the 21st Century (TEA-21) prohibited the Secretary of State for transportation from *approving any project or taking any regulatory action that will result in the severance of an existing major route or have an adverse impact on the safety of non motorised transportation traffic and light motorcycles, unless such project or regulatory action provides for a reasonable alternate route or such a route already exists*.

New, dedicated, bus facilities in exclusive rights of way, also provide opportunities for creating new cycle and pedestrian facilities and movement opportunities along the same alignment (see Information Note 17, *New Bus Facilities*). As well as enhancing the route options available to cyclists and pedestrians, such facilities also improve the accessibility of bus stops and stations along the route, potentially increasing bus patronage especially if bicycle parking is also provided (see Information Note 7, *Bicycle Storage Facilities*) and enhancing the accessibility of locations along the route.

References

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CONTINUITY AND CONSISTENCY

Issue

Continual changing of conditions for cyclists and other road users along a route fosters uncertainty and unpredictable behaviour, particularly at those places where conditions change, and will act as both real and perceived barriers to use by cyclists. Such change points are likely to be hazardous in themselves, especially where sub-optimal treatments are imposed by, for example, road-space constraints and high traffic volumes.

Recommended Approach

Bus and cycle priority should be considered on a route and area basis as well as on the basis of specific situations. Bus priority should be addressed on an integrated basis, taking into account all road users and local as well as regional trips, providing benefits for all environmentally-friendly modes(including cycling and walking). *Red Routes*, first introduced in London and now being introduced in the West Midlands (http://www.redroutes.org.uk/index.htm) and Edinburgh's *Greenways* (http://www.buspriority.org/greenways.htm) provide useful examples of best practice (see Figure overleaf for an example).

Discussion

The most 'obvious' candidates for bus priority are those places where there is an immediate problem that would impose a high probability or high level of delay to buses and bus users. These will often be where traffic volumes are high, traffic speeds are low and vehicle movements are complex. However, intermittent bus priority can lead to uncertainty with changing conditions along a route and may adversely affect other road users and users of the area through which the bus routes pass.

More generally, bus priority may advantage those moving through an area to the potential detriment of users of an area, for example by making it more difficult to cross the road or by increasing the speed of buses while slowing other traffic. In doing so, it may encourage longer-distance, regional travel at the expense of local access and activities, potentially working against strategic transport and land use objectives that aim to promote localisation of activities and to reduce the need to travel.

Local centres, many of which are located on bus routes, will often be focal points in bicycle networks (and pedestrian networks), and routes will cross as well as coincide with bus routes. The same applies to other activities (eg schools) that are located along major bus routes. Local centres are also of particular importance to people with mobility impairments.

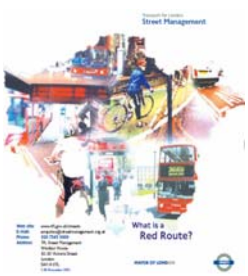
It is important that the needs of all users are given equal weight in planning transport and access to and through activity centres and along bus routes in general. In particular, whilst bus services (relative to the private car) for through travel and some travel to such centres should rightfully be given a high priority, this should not be at the expense of other environmentally-friendly modes. Planning and design for access should be based on a comprehensive and integrated approach to routes and areas and all modes rather than being based on the primacy of any single mode.

Priority provision for one alternative to the car can be detrimental to others. In London, the West Midlands and Edinburgh (United Kingdom), an integrated approach to the management of major transport corridors has emphasised improvements for all non-car modes, and even some improvements for car users through better parking provision and management, rather than a single focus on bus priority.

Red Routes, originally developed in London and now being introduced in the West Midlands in England, have the principal objective of improving the London road network for pedestrians, cyclists, bus passengers, people with disabilities, drivers and for the movement of goods. Red Routes have been developed under the strategy of Street Management rather than focusing on only one element of traffic.

With regard to bus services, Red Routes help to keep the Transport for London Road Network (TLRN) clear, allowing buses to keep moving, which improves journey times.

Red Routes and Greenways



Red Routes, widely used in London and now under consideration in Birmingham, are an integrated approach to improving conditions for all users. The Red Route 'package' includes:

- Better bus services – bus lanes; bus priority at traffic signals; bus stop protection from obstruction; better information and facilities for passengers; queue-jump facilities for buses.
- Safer cycling – advisory cycle routes; cycle tracks and lanes; advance stop lines at junctions and signals; strategically-placed crossing points.
- Pedestrian safety - better pedestrian crossings; less clutter on footpaths; reduced congestion; kerb ramps at crossing points; traffic calming at side street junctions.
- Improvements for people with disabilities, including parking concessions.

In the case of London's Red Routes:

- Bus journeys were 10% quicker and 27% more reliable.
- Both general traffic speeds and journey time reliability were improved by 20%.
- Red Routes had no adverse effect on retail and business performance.
- Red Routes led to a 6% reduction in accidents, 9% in accidents involving pedestrians and 8% for cyclists.

'Greenways', in Edinburgh, are similar to 'Red Routes' but have greater emphasis on bus priority lanes. General traffic is banned from Greenways, with access restricted to buses, taxis and bicycles. Greenways differ from conventional bus priority in a number of ways:

- lanes are surfaced in green tarmac;
- red lines prohibit stopping;
- a dedicated team of wardens strictly enforces Greenways;
- side streets have traffic calming measures;
- there is better provision for cyclists and pedestrians;
- Greenways operate throughout the working day; and there are better bus shelters with comprehensive bus information.

With regard to cycling, the London Cycle Network has cycle lanes that often cross or run along Red Routes. Special measures for cyclists include:

- advisory cycle routes;
- cycle tracks and lanes;
- advance cycle stop lines at junctions and signals; and
- strategically placed crossing points.

Another form of consistency is the promotion of bus lanes as cycle routes in the Central Sydney Bikeplan:

The City must provide a range of transport options, and is keen to provide appropriate facilities for cyclists, but it is crucial that these facilities are not to the detriment of the public transport system or pedestrian facilities and amenity. The City generally favours integrating bicycles with other transport options and users, particularly as it is a low speed environment. For this reason, bicycle travel within the CBD is accommodated via the extensive network of bus lanes, with cyclists generally sharing the road with other traffic users. (http://www.cityofsydney.nsw.gov.au/pdf/attachment-central-sydney-bike-plan.pdf).

Red Routes – Improving conditions for all users, not just buses

Better bus services

Red Routes help to keep the TLRN clear allowing buses to keep moving, which improves journey times.

As well as bus lanes, the TLRN includes:

- bus priority measures at signals
- bus stop protection from obstruction, with better information and facilities for passengers
- special 'advance areas' for buses to move to the front of queues at signals.

Safer cycling

The London Cycle Network has cycle lanes that often cross or run along Red Routes.

Special measures for cyclists include:

- advisory cycle routes
- cycle tracks and lanes
- advance cycle stop lines at junctions and signals
- strategically placed crossing points.

Pedestrian safety

Nearly every journey involves walking and pedestrians are given special consideration on Red Routes.

Improvements include:

- better pedestrian crossings, which improves safety
- less clutter on pavements
- reduced congestion
- dropped kerbs at crossing points
- traffic calming at side road junctions.

Improvements for people with a disability

A wide range of facilities are provided for people with a disability.

Orange and Blue Badge holders can use the parking spaces provided; can stop for up to three hours in nearly all loading 'boxes'; and can stop for an unlimited time in parking 'boxes'.

Transport for London

Street Management

To report a faulty traffic light anywhere in London, we have a 24 hour fault line
020 7941 2345

Web site: www.tfl.gov.uk/streets
E-mail: enquiries@streetmanagement.org.uk
Phone: 020 7343 5000
Address: TfL Street Management
Windsor House
42-50 Victoria Street
London
SW1H 0TL
5 84 November 2002

What is a Red Route?

MAYOR OF LONDON

What is a Red Route?

Transport for London (TfL) Street Management is responsible on behalf of the Mayor of London for operating and improving road conditions for all road users on 580km of London's most important roads – the Transport for London Road Network (TLRN).

The TLRN accounts for around 5% of London's roads and carries 33% of traffic. London's 33 local authorities manage the other roads, apart from motorways that are run by the Highways Agency. All TLRN roads are, or soon will be, Red Routes.

Red Routes were introduced to maximise the efficiency of limited road space and update inadequate yellow line parking controls. They help us to improve the TLRN for pedestrians, cyclists, bus passengers, people with disabilities, drivers and for the movement of goods.

Red Route lines and signs

Double red lines
Stopping is not permitted at any time. Double red lines are seen only at important junctions, bus stops or where parking or loading would be dangerous or cause serious congestion.

Single red lines
Parking, loading or picking up passengers is not permitted during the working day.
The controls generally apply from 7am to 7pm. Stopping is permitted outside these hours and on Sundays.

Red Route Clearway
Part of the TLRN is made up of 'Clearways'. On these roads there are signs but no red lines except at some roundabouts and junctions. Stopping is only permitted in marked lay-bys.

Stopping: red boxes - Red 'boxes' marked on the road indicate that parking or loading is permitted during the off peak times, normally between 10am and 4pm. There are several different types of box. Some allow loading and unloading. Others allow short term free parking. Special conditions apply to Orange and Blue Badge Holders. The rules in each case are clearly shown on a sign beside the box.

Stopping: white boxes - White 'boxes' marked on the road indicate that parking or loading is allowed at any time of day. Times and conditions are clearly indicated on the signs displayed next to the 'box'.

There is a fixed penalty of £60 for an offence and illegally parked vehicles may be towed away.

Red Route benefits

Police Traffic Wardens enforce Red Route controls which have significantly reduced inconsiderate and often illegal parking. However, our work on the TLRN goes far beyond this as we strive to achieve our vision of 'the world's best managed streets for a world class city'.

Red Route improvements include:

A better environment
Red routes help to keep traffic moving and reduce the pollution that comes from vehicle emissions. Thousands of new trees have been planted along Red Route roads to help improve the environment for all road users.

Parking improvements
Visiting shops on Red Routes is often easier because legal parking is provided free of charge in many places. Parking is often provided where there was none before and these short-term parking 'boxes' help businesses and encourage shoppers.

Red Route controls have significantly reduced inconsiderate and often illegal parking

CYCLE AUDIT

Issue

Public transport infrastructure and traffic management measures that assist public transport can have negative impacts on cycling in many different ways, causing cyclists delays, inconvenience and increased risk of crashes. There is currently no systematic process applied nationally to ensure that before measures to promote and assist public transport are introduced, steps are taken to overcome adverse cycling impacts and, where possible, improve cycling facilities.

Recommended Approach

Proposals that have potential impacts on the convenience or safety of cyclists should be subject to a cycle audit process (see, for example, Austroads, 1999, Appendix A, for an example of a cycle audit checklist). To make cycle audit more specifically appropriate to proposals for bus priority, the following additional items should be considered:

- If a bus lane is proposed, will cyclists be allowed to use it, and if they will, will the bus lane be of sufficient width to accommodate buses and cyclists. If they will not, is there an alternative route that is suitable for cyclists?
- Have bus stops and bus shelter locations been designed to allow the safe passage of bicycles past them?
- Where buses are required to turn next to cyclists, does swept path of the buses encroach upon the cyclists' road space?
- If 'B' bus priority lights are proposed, has consideration been given to the needs of cyclists?

It follows, also, that proposals for cyclist use of bus priority facilities should be assessed for the impact on bus users.

Discussion

The owner of one sustainable mode of transport has a responsibility to avoid detrimental impacts on other sustainable modes. Because buses and cyclists are often required to use the same area of road space, measures introduced to assist buses can often cause difficulties to cyclists. Examples are:

- The provision of a bus lane that cannot be used by cyclists and where no alternative route for cyclists is provided;
- The installation of a bus stop or bus shelter on a cycle path;
- A large increase in the number of buses turning left at an intersection where the predominant cycle route is straight ahead.

A process that can be used to assess the cycle friendliness of public transport proposals is the Cycle Audit. This is a systematic review process applied to planned changes to the general transport network and can equally be applied to bus transport measures. It is designed to ensure that cycling conditions are not inadvertently made worse and that opportunities to encourage cycling are considered comprehensively. Audits are carried out on concept, preliminary or detailed designs for infrastructure proposals that impinge in one way or another on cycling. The same process can be used to assess existing cycling facilities to enable improvements to be developed, and this is called a Cycle Review. The use of the Cycle Audit process will assist planning, road and transport authorities to create a cycle friendly infrastructure, make existing roads safer, and make cycling more attractive.

Cycle Audit can be defined as *a systematic process, applied to planned changes to the transport network, which is designed to ensure that opportunities to encourage cycling are considered comprehensively and that cycling conditions are not inadvertently made worse*. In short, Cycle Audit is used to examine new highway schemes for cycle-friendliness. It involves auditing schemes (including maintenance) at various stages of design and implementation. It is important to bear in mind that Cycle Audit does not in itself constitute a set of design standards for cycle facilities.

The Cycle Audit process can be used to ensure that the particular issues and interests relating to cyclists are fully considered in the processes for reviewing, planning, designing and constructing bus facilities that may have an impact on them.

The aim of a Cycle Audit is to ensure that good cycling infrastructure is achieved wherever possible. It involves the appraisal of a design by a "fresh pair of eyes". A team-based approach involving 2 to 4 suitably experienced people can be used to increase the range of experience brought into the audit process. Whether working alone or as the leader of an audit team, the person responsible for carrying out the audit should be experienced and trained in examining cycling facilities.

It is also important that the auditor and the audit team are independent of the design process.

Proposed bus infrastructure and traffic management measures to assist public transport should be Cycle Audited at their various stages of design. The earlier a Cycle Audit is undertaken, the more likely it is that solutions can be found to identified problems without incurring excessive costs. Ideally, every new scheme should be audited for cycle friendliness. However, the amount of time and effort put into an audit should reflect both the current level of cycle use and the likely extent of any suppressed demand.

In general terms, a Cycle Audit is carried out by considering the following five headings:

- Coherence;
- Directness;
- Attractiveness;
- Safety;
- Comfort.

In practice this means that cycle routes need to be:

- Direct and continuous and follow the routes people would wish to take;
- Safe from conflict with other traffic (junctions and intersections are usually the main problem);
- Free from unnecessary barriers such as gates and steps;
- Well lit;
- Well surfaced and clear of gravel or other debris;
- Well signed; and
- Served by good connections with other local cycle routes.

Ideally a Cycle Audit should be carried out using a checklist to assist the auditor / audit team. The auditor/ audit team will use the checklist to produce an Audit Report to the asset owner or project designer drawing attention to any issues relating to cycling impacts of the proposals that need addressing. No comprehensive Cycle Audit Checklist suitable for use when auditing bus related proposals has been found during preparation of this report. Such a checklist would be an invaluable tool for checking that bus related proposals are cyclist friendly and it is recommended that it should be prepared and made available to road authorities, design consultants, bus service planners and bus operators.

The UK Department for Transport publishes a useful document on carrying out Cycle Audits (IHT, 2001). A summary leaflet (DETR, 2001) outlines the process.

The Austroads publication, Guide to Traffic Engineering Practice Part 14 – Bicycles, includes an example of a Bicycle Safety Audit Checklist. This could be used as a basis for a Cycle Audit checklist, although an additional section of checklist questions relating to buses needs to be included as follows:

Bus Facilities

- *If a bus lane is proposed, will cyclists be allowed to use it, and if they will, will the bus lane be of sufficient width to accommodate buses and cyclists. If they will not, is there an alternative route that is suitable for cyclists?*
- *If other forms of bus priority are proposed, what are the impacts on cyclists? Does the bus priority restrict access for cyclists or put cyclists in more vulnerable positions in the roadway?*
- *Have bus stops and bus shelter locations been designed to allow the safe passage of bicycles past them?*
- *Where buses are required to turn next to cyclists, does swept path of the buses encroach upon the cyclists road space?*
- *If 'B' bus priority lights are proposed, has consideration been given to the needs of cyclists?*

An example of a specific Cycle Audit checklist, prepared by the Corporation of London, shows how the various issues related to cycle friendliness can be considered systematically. However the checklist would need supplementary questions similar to those suggested above for the 'Guide to Traffic Engineering Practice Part 14 – Bicycles' Safety Audit Checklist.

The cycle audit technique is still being developed locally and internationally, but experience in the UK shows that it has the capability to provide substantial improvements in facilities that are provided for or impact upon cyclists.

References

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

DETR (2001). *Cycle Audit and Review.* Department of Environment, Transport and the Regions: London, UK. http://www.dft.gov.uk/stellent/groups/dft_roads/documents/pdf/dft_roads_pdf_504721.pdf

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FACILITY DESIGN: SHARED BUS-BIKE LANES

Issue

The inherent speed differential between these modes, and the frequent stopping of buses, often leads to 'leap-frogging' or bus delays. Such leap-frogging is difficult with minimum-width bus lanes and heavy adjacent general traffic. The issue is, therefore, should shared bus & cycle lanes be wide enough for overtaking, or should this be discouraged?

Recommended Approach

Where possible, bus/cycle lanes should be of sufficient continuous width (min 3.7m) to enable overtaking within the lane. If the required space is not consistently available, widening should be carried out where possible to provide occasional overtaking opportunities. This would most likely be achievable as localised widening at bus stops, which would also allow cyclists to pass buses stopped to pick up or drop off passengers (see Information Note No. 9, *Bus Stop Design*). Bus/bicycle lane widths between 3.0m and 3.7m are not recommended as this would encourage attempts at overtaking within the lane where there is insufficient margin for safety.

Consideration should be given to cyclists only being allowed to ride in single file in bus lanes, to maximise opportunities for buses to overtake, where the Bus Lane is wide enough to allow such overtaking with safety.

Information Note 18, *Bus Lane Regulations*, discusses issues that may arise where a lane wide enough to allow bus/bicycle overtaking cannot be provided. The following options should also be considered:-

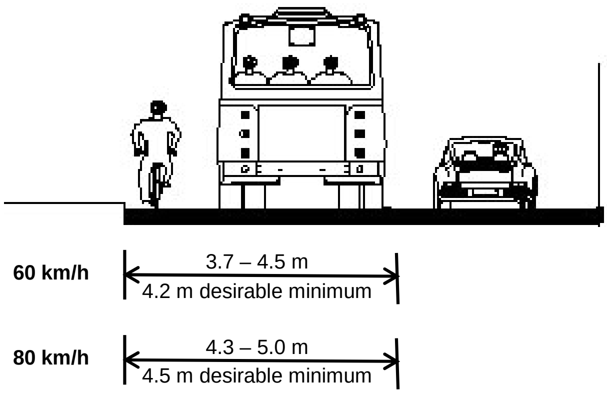
- Provide a separate off-road cycle facility. This may be the most desirable option, even if space is available for widening, but should not be at the expense of the cyclists' level of service (convenience, comfort and safety);
- Provide an alternative cycle facility on a more suitable, parallel road instead (see also Bus-Bike Guideline No. 1, Network Planning, and Bus-Bike Guideline No. 3, Cycle Audit); or
- Remove cycles from the bus lane, if this can be achieved without reducing the level of service (safety, convenience, amenity) for cyclists.

Discussion

In most cases, bus lanes are not installed alongside a kerbside parking area, so there should be no issues with cyclists having to ride too close to the potential hazard of opening doors. However, should a bus lane be installed alongside kerbside parking (eg where car parking is embayed into the verge), the lateral clearance requirements set out in *GTEP Part 14, Bicycles* (Austroads, 1999), with respect to 'bicycle/car parking lanes' (section 4.4.2) and 'wide kerbside lanes' (section 4.4.7) should be complied with. In particular, the lateral clearance to the left of the bus/cycle lane should be in accordance with the specification for the 'safety strip' in Figure 4-6 in GTEP Part 14 and the width of the bus lane in accordance with Figure 4-19.

As can be seen below, the faster the bus speed, the wider the lane needs to be.

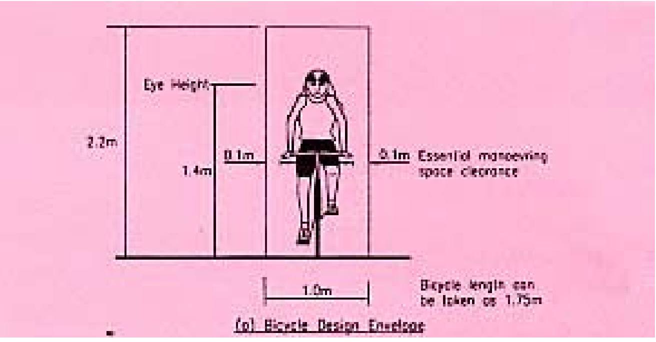
Widened bus/cycle lane



Source for dimensions: Austroads (1999)

Although the lane width is usually measured from the kerb face, as is the case with Austroads (1999), Austroads adds the qualification that *the width of road gutters/channels (comprising a different surface medium) should be less than 0.4m where minimum dimensions are used … Where there are poor surface conditions over a section of road adjacent to the gutter, then the width of the Wide Kerbside Lane should be measured from the outside edge of that section* (Austroads, 1999, p33). The implication is that cyclists should ride with wheels not less than 0.5m from the kerb and that the whole cyclist design operating space (Austroads, 1999, Fig 3-1) should be accommodated within the roadway and not overlap the kerb.

Cyclist Operating Envelope (Austroads, 1999)



Cyclist safety can be enhanced by the use of edgeline markings where there are road gutters or channels of 400mm or more.

Lane Width Should Allow for Wide Gutters or Channels

Victoria has recently approved the use of wide kerbside lane markings after studies found that:

- 86% of motorists and 95% of bus drivers understood the marking to mean that a bicycle facility for shared use had been provided and that it is likely that cyclists would be using the road; and
- 90% of motorists agreed that the symbol is a useful reminder that cyclists are likely to be using the road.

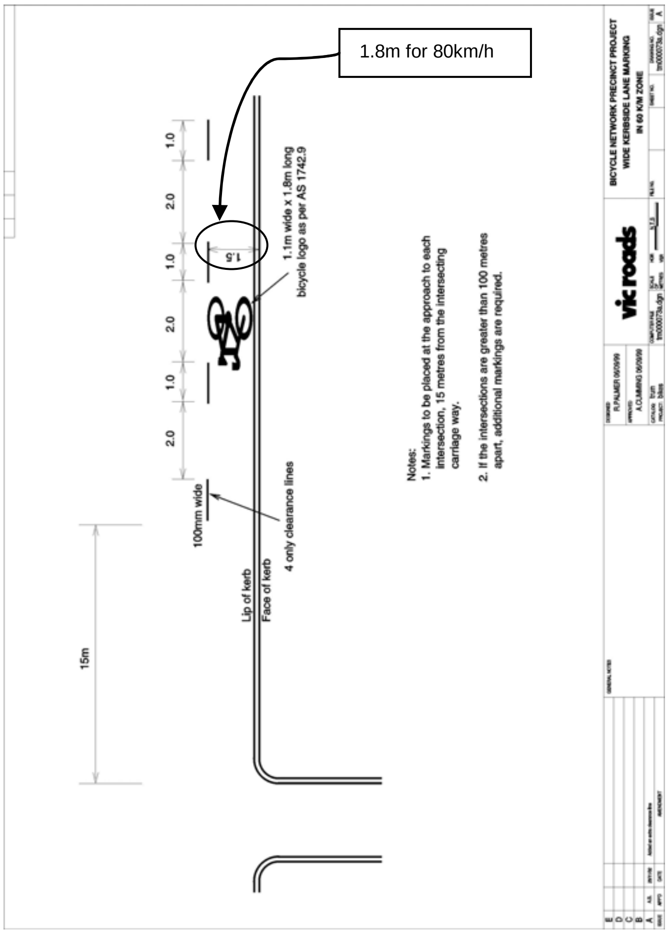
The markings are designed for use in wide general traffic lanes where these are part of a designated bicycle network, but the high level of recognition by bus drivers is particularly important in the present context.

If shared bus and cycle lanes are not wide enough for overtaking within the lane, the bus driver may follow one of the following courses of action:-

- Overtake the cyclist by moving either partially or completely into the general traffic lane (where such a manoeuvre is allowed); or
- Remain in the bus lane, following the cycle at reduced speed, until either the bus has to stop, or the cyclist leaves the lane.

Either of these choices reduces the benefit of the bus lane and has safety and travel time implications. They could also lead to driver frustration and increased friction between the modes.

Wide Kerbside Lane Marking for 60km/h Zone



Source: VicRoads

However, to provide lanes of sufficient width to allow overtaking may require additional road space, which may not be available.

The options to be considered in this case depend to a large extent on the road width available (and the length over which it is available).

Where there is sufficient road space such that the lanes can be wide enough to allow overtaking, with a reasonable margin of safety, this would enable the two modes to co-exist more readily. The width should be consistent if possible, but in some cases it may only be possible to provide widened sections at intervals. In this event, there may still be occasions where buses have to follow cyclists until they reach the next overtaking opportunity. It should also be noted that occasional widening of the lane, (whether this occurs over a short distance, with tapered ends akin to an embayment, or more gradually over a longer distance), will create potential hazards as the two modes merge again into the narrower sections.

Reference

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

Bus-Bike Interaction Within The Road Network

Information Note No 5 February 2005

AUSTROADS

FACILITY DESIGN: SEPARATE BUS & BIKE LANES

Issue

When parallel bus and cycle lanes are provided, both within the road space, they may be either physically or visually separated, and either one may be located adjacent the kerb. However, if the cycle lane is next to the kerb, there will be increased issues with bus stop conflicts. On the other hand, if the bus lane is next to the kerb, cyclists will have traffic on both sides.

Recommended Approach

It is generally recommended that the cycle lane should be located adjacent the kerb. Solutions to the issues regarding conflict at bus stops are discussed in Information Note 10, *Cycle Lanes at Bus Stops*.

Where a bus lane is established away from the kerb, for example to allow for all-day operation in conjunction with off-peak car parking, it may be possible to install a combined bicycle/car parking lane if there is insufficient roadway width for separate parking and bicycle lanes.

Cycle lanes or bicycle/car parking lanes adjacent to bus lanes should be designed, constructed and signed in accordance with Austroads (1999, Chapter 4).

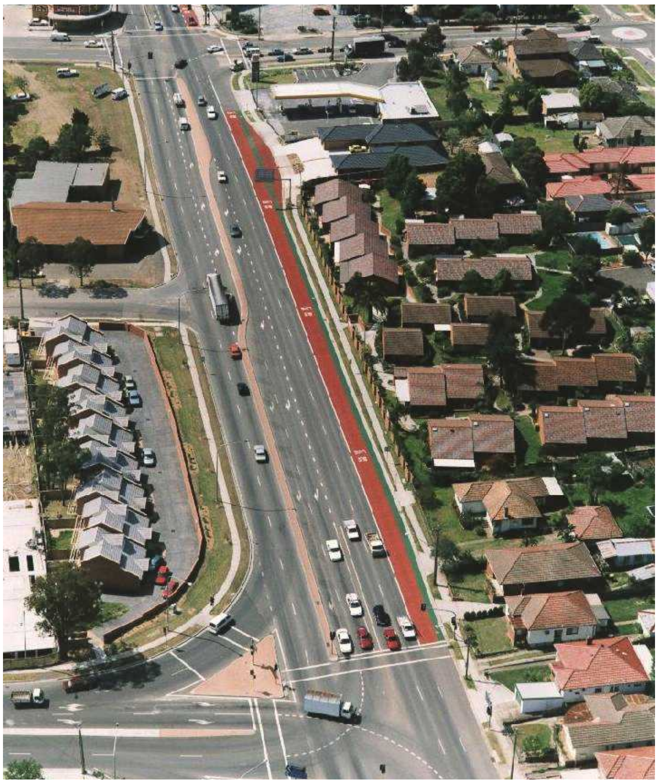
There are various ways of differentiating the two lanes, including different colour road surfacing and line marking. A wider separation line may assist in keeping cyclists and buses further apart, especially where the bus lane is narrow and/or hemmed in by large vehicles using the adjacent traffic lane.

Discussion

There are various ways of differentiating the two lanes, and some options are shown in the following photographs, including different colour road surfacing and line marking.

The second photograph also shows how buses often need to encroach onto the cycle lane when alongside other large vehicles. A wider separation line may assist in keeping cyclists and buses further apart, especially where the bus lane is narrow and/or hemmed in by large vehicles using the adjacent traffic lane.

Bike Lanes Can Continue Past Embayed Bus Stops



Narrow Bus Lane Can Cause Encroachment into Cycle Lane

If the cycle lane is located next to the kerb, there are a number of issues to be considered. This option is generally seen as preferable for cyclists as they only have moving traffic on one side, but there will be conflict when a bus needs to approach the kerb at bus stops (see Information Note 10, *Cycle Lanes at Bus Stops*). The bus driver will need to make a decision, based on the proximity to the stop and the speed of the cyclist, as to whether to pull across in front of the cyclist, or wait for it to clear the stop (see also Information Note 20, *Bus Driver and Cyclist Attitudes and Behaviour*).

With the cycle lane at the kerb, it is easier to create a physical separation between the lanes, if this is desirable. It is also easier to obtain a smooth transition when the bus and/or cycle lane starts/ends.

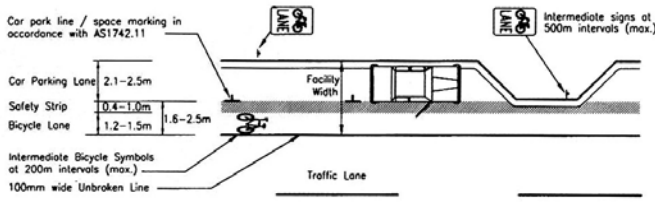
Conversely, with the bus lane at the kerbside, although cyclists have traffic passing on both sides, they will not be unduly inconvenienced by stopping buses. Non-stopping buses will nonetheless need to move out into the cycle lane when passing a stopped bus.

In either case, general traffic has to cross both the bus and cycle lanes to approach the kerb, eg for turning left or turning into driveways, and the ability of car drivers to be aware of and see cyclists should be carefully considered. Cyclist visibility is likely to be greater in a lane at the kerbside, where the visual environment is less complex. This is also where drivers would normally expect a cyclist to be.

There may be difficulties associated with physical separation of a central cycle lane, and weaving difficulties when the bus &/or cycle lane starts/ends.

Where a bus lane is established away from the kerb, for example to allow for all-day operation in conjunction with off-peak car parking, it may be possible to install a combined bicycle/car parking lane if there is insufficient roadway width for separate parking and bicycle lanes.

Combined Cycle/Parking Lane



Source: Austroads (1999, p24)

Where there is a non-kerbside bus lane of this type and insufficient road width for the above treatment, it is imperative that cyclists are allowed to use the bus lane, unless a separate facility is provided, as there is no other continuously-accessible 'path' available to them (see also Information Note 18, *Bus Lane Regulations*).

Non-Kerbside Bus Lane with Insufficient Kerbside Lane Width for Cycle/Parking Lane

Where separate facilities are provided, interaction and conflict between buses and cyclists are significantly reduced. However, some issues still remain, particularly at:-

- bus stops (see Information Note 10, *Cycle Lanes at Bus Stops*);
- roundabouts (see Information Note 8, *Roundabouts*);
- other junctions, especially with respect to cycle or bus turning movements (see Information Note 7, *Bus Left Turn*);
- locations where the bus or cycle lanes begin and end (see Information Note 2, *Continuity and Consistency*).

Reference

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

FACILITY DESIGN: BUS STATION ENTRY/EXIT

Issue

The entry and exit points for bus stations inevitably have high concentrations of bus movements often in complex environments involving turning and other vehicle manoeuvres.

Recommended Approach

It is desirable for cyclists to be provided with a separate access route into modal interchanges, rather than to be required to use those points of entry (or internal roadspace) where buses will be present. This is often already the case with cars whereby the access to park and ride or kiss and ride areas is separate from the bus access. It is suggested that cyclists should make use of the car access if it is impractical to provide a completely separate cycle access.

Careful attention will need to be paid to visual or physical separation of cyclist and other space, including access for both buses and bus passengers/pedestrians. In some cases it may be desirable to have grade separation where the overall level of conflict is high.

Discussion

The entry and exit points to bus stations need to be designed in such a way as to minimise potential conflict between the two modes. It is not necessarily desirable for cyclists to be allowed to use the same access or egress points as buses. The swept path tolerance within bus stations is usually minimal, and cyclists should be kept away from those areas where buses might be manoeuvring or reversing.

The picture below, which is of the Christchurch (New Zealand) Central City Bus Exchange, illustrates some of the complexities.

There are two exits from the Bus Exchange (on the left of the picture). The nearer one is for buses going contra-flow to a nearby intersection, where they present in a potentially unexpected position on the road (on the 'wrong' side of the road). The further one is for buses turning away from the camera and allows entry into a bus lane.

Cyclists may ride in this bus lane and may also ride in the line-marked shoulder area between the traffic and the median separating traffic from the nearer exit – although it is not signed as a bike lane.

The Christchurch set-up appears to work, but is potentially confusing to users who are unfamiliar with it.

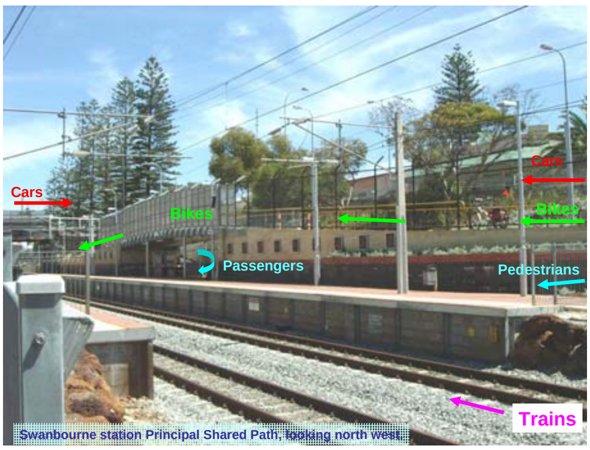
Some signage to warn of bus movements and possibly a 'give-way' line/sign for the shoulder to define priority at the far exit would enhance safety. This priority could be either way (ie for the exiting buses or for the through cycle movement, depending upon the relative levels of usage.

Complexity at Bus Station Entry and Exit (left of picture)

Photo: Glen Koorey

Where the overall level of conflict with either buses or bus passengers/pedestrians is high, grade separation may be desirable. Whilst this is more commonly associated with train stations, it may be equally applicable to high-volume bus station locations.

Grade Separation may be necessary to reduce conflict



FACILITY DESIGN: BUS LEFT TURN AT INTERSECTIONS

Issue

Bus turning movements can pose 'blind-spot' and 'swept-path' issues, especially where the bus is making a left turn from a dedicated left-turn lane and lane geometry is inadequate for the bus to remain totally within the turning lane. This especially important for cyclists travelling straight through the intersection as they will usually be close to the left of this lane, immediately to the right of the left-turn lane

Recommended Approach

All buses should carry the pictorial 'do not overtake turning vehicle' sign at both left and right rear corners of the vehicle at cyclist eye-height.

Wherever possible, intersections and junctions with left-turn bus movements should be designed in accordance with the geometric design recommendations of the Austroads (1991) Guide to Traffic Engineering Practice, Part 5, Intersections at Grade – specifically, section 5.7, Left Turn Treatments.

In some cases, it may be necessary to set back the stop line on the intersecting road to allow the bus to encroach into the opposing direction of traffic.

The forthcoming Guide to Traffic Engineering Practice, Part 16, On-Road Public Transport will address details of requirements for road design for ULF buses at intersections in more detail.

See also *Information Note 20, Bus Driver and Cyclist Attitudes and Behaviour*, and *Information Note 22, Bus Rear View Mirrors*, dealing with lateral movement of buses within the roadway.

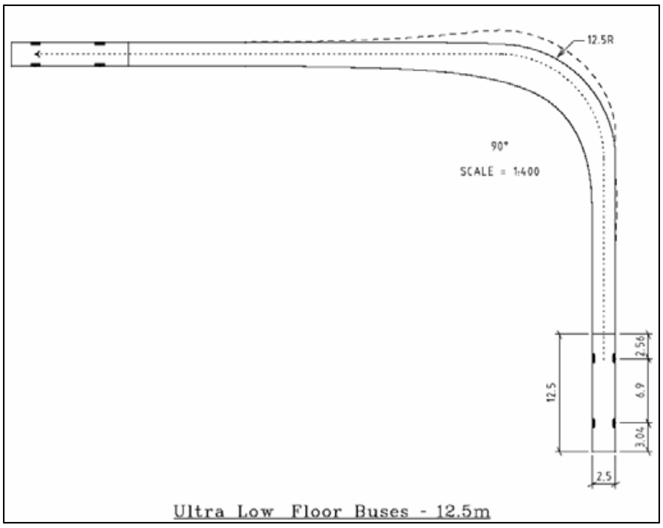
Discussion

Most of the issues regarding conflict between bus/bikes at intersections appear to be common to the interaction of bicycles with any large vehicle.

Whilst ultra-low floor (ULF) buses have the same length and similar operating characteristics as the standard Austroads design bus, the more modern ULF buses have a greater steering angle, which provides increased manoeuvrability in negotiating local road traffic management treatments. However ULF buses also have a lower and longer front overhang which must also be taken into account in designing intersections.

These conflicting requirements are demonstrated in the following Figure where the higher steering angle has been used to allow the ULF bus to turn on a radius of 10.8 m to the outside front wheel, compared with the 12.5 m radius standard adopted for the Austroads single unit truck/bus design vehicle. Nevertheless, in spite of the smaller turning radius, the overall swept path of the ULF bus through the turn is similar to the Austroads vehicle because of the longer front overhang.

Turning Template for Ultra-Low Floor Bus



In either case, a bus turning left into another road will often have to move away from the kerb before starting the turn to the left, in order to complete the turn within the appropriate lane(s) of the road into which it is turning.

Regulation 28(2) of the *Australian Road Rules* (ARR) states that:

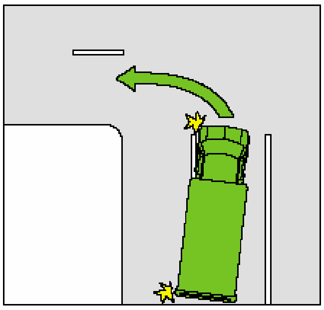
(2) A driver may approach and enter the intersection from the marked lane next to the left lane as well as, or instead of, the left lane if:

- (a) the driver's vehicle, together with any load or projection, is 7.5 metres long, or longer; and
- (b) the vehicle displays a *do not overtake turning vehicle sign*; and
- (c) any part of the vehicle is within 50 metres of the nearest point of the intersection; and
- (d) it is not practicable for the driver to turn left from within the left lane; and
- (e) the driver can safely occupy the next marked lane and can safely turn left at the intersection by occupying the next marked lane, or both lanes.

The ARR provide the following illustration, which is one that is commonly undertaken by buses in many older urban areas, where corner radii are often tighter than advised by current design standards.

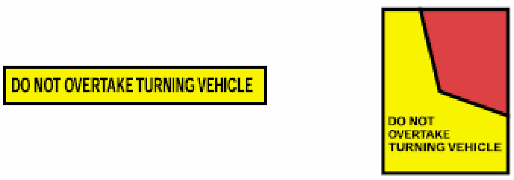
Example

Long vehicle turning left from the left lane and next marked lane



Regulation 28(2), however, also requires that vehicles undertaking this manoeuvre display the specified sign (below), which is intended to alert following vehicle operators that the vehicle may move to the right prior to turning left. Buses may not display this sign or may use only the word version (left), sometimes situated low and to the left of the vehicle.

Do not overtake turning vehicle signs



Note for diagrams These signs are displayed on certain long vehicles.

Whilst the left side of the vehicle may be appropriate to alert cyclists not to overtake to the left, the sign is too low for cyclists to read easily. The pictorial sign is more commonly used on freight vehicles and could be placed above the lower light panels on both right and left of the above bus (right picture).

Warning Signs on Buses can be Improved

The volume and speed of traffic will influence the approach speed of a bus to an intersection. Whilst all buses will slow significantly when making a left turn, the approach speed may be such that the swept path exceeds the design template and/or the physical space available. In some cases, it may be necessary to set back the stop line on the intersecting road to allow the bus to encroach into the opposing direction of traffic (below).

Stop Lines On Intersecting Roads May Be Set Back To Allow Buses To Remain In The Kerbside Line On Approach To Left Turn

The bus shown above is able to stay in the kerbside lane entering the intersection, whilst limiting the extent to which it delays other traffic by slowing, only because the driver knows that stopped vehicles on the intersecting road will be far enough back to allow the bus to encroach into the opposing direction of traffic safely.

FACILITY DESIGN: ROUNDABOUTS

Issue

Roundabout design is a key issue for buses and bicycles both in the context of their interaction, and individually. The appropriate solutions for one might compromise safety and convenience for the other. The issues may also vary depending on the size of the roundabout, i.e. those with only a single circulating lane compared to those with two or more.

Recommended Approach

On single-lane roundabouts, care should be taken to ensure that the design facilitates bus movement, especially for right turns, without distracting the driver from the possible presence of cyclists. The design should preclude a bus passing a cyclist when negotiating the roundabout. It may be desirable to indicate that cyclists should occupy a position away from the kerb, to prevent passing by buses (or other vehicles).

Larger roundabouts pose a range of problems for cyclists that need to be considered in the overall traffic context, not just with respect to buses.

Each situation should be assessed individually to arrive at the most appropriate solution.

Discussion

Cyclists are particularly vulnerable on roundabouts due to the potential for conflicting movements and, especially on smaller roundabouts with tighter radii, from the exaggerated swept paths of longer vehicles. These issues are relevant here, but are clearly not limited to the interaction between bicycles and buses.

However, ultra-low floor (ULF) buses (which are now the industry-standard following proclamation of the Accessible Public Transport Standards under the Disability Discrimination Act, 1992), whilst having a tighter turning circle than older conventional buses, do so at the expense of having greater front and rear overhangs. These are especially important in situations where the bus is required to turn around tight-radii as in many single-lane roundabouts.

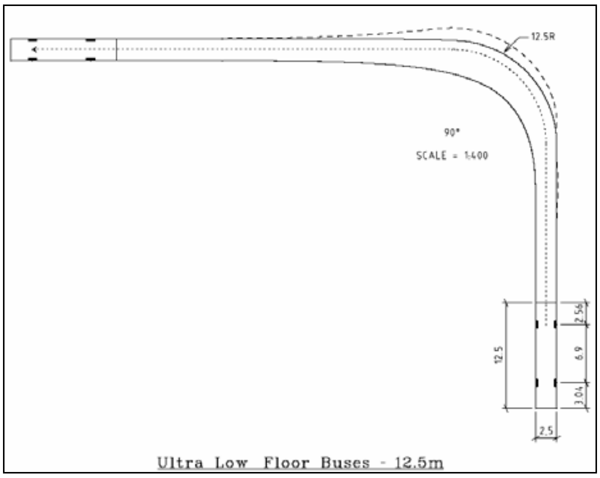
Illustration of swept path requirements of Ultra Low Floor bus

Whilst ultra-low floor (ULF) buses have the same length and similar operating characteristics as the standard Austroads design bus, the more modern ULF buses have a greater steering angle, which provides increased manoeuvrability in negotiating local road traffic management treatments. However ULF buses also have a lower and longer front overhang which must also be taken into account in designing roundabouts.

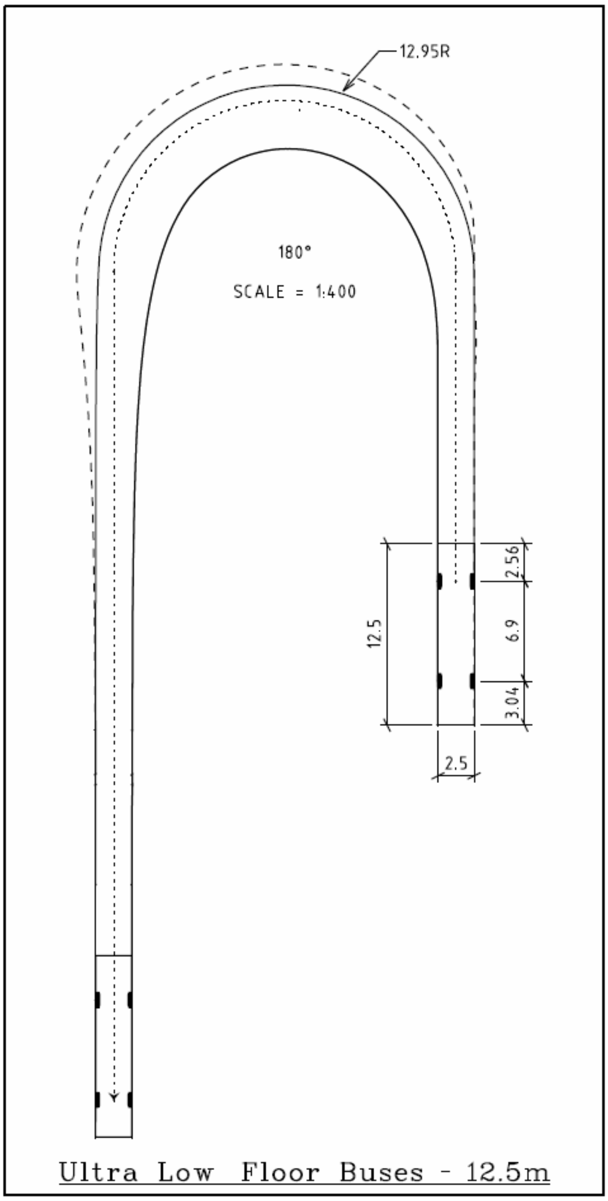
These conflicting requirements are exemplified in the higher steering angle which allows the ULF bus to turn on a radius of 10.8 m to the outside front wheel, compared with the 12.5 m radius standard adopted for the Austroads single unit truck/bus design vehicle. Nevertheless, in spite of the smaller turning radius, the overall swept path of the ULF bus through the turn is similar to the Austroads vehicle because of the longer front overhang.

Turning Templates for Ultra-Low Floor Buses

90 Degrees/12.5 metre Radius



180 Degrees



The forthcoming Guide to Traffic Engineering Practice, Part 16, On-Road Public Transport will address details of requirements for road design for ULF buses at roundabouts.

For larger roundabouts, the three basic options are:-

a) Provide a separate lane for cyclists (probably around the outer kerb).
   - potentially more dangerous for cyclists, particularly as they cross the exit lanes;
   - may still be side swiped by the front overhang or 'wagging tail' of a bus; and
   - treatment may need to be discontinuous at the exits to avoid conflicting with legal priority of exiting vehicles (RTA, 2003, Section 7.2.6).

b) Cyclists mix in with general traffic.
   - also dangerous for inexperienced cyclists (regardless of the presence of a bus);
   - visibility issues on larger roundabouts;
   - workable on smaller roundabouts if cyclists remain central in the lane. (Buses will need to reduce speed to negotiate smaller roundabouts);
   - Cyclists must be educated to give clear signals of their intentions.

c) Remove cyclists from the circulatory road space.
   - May be desirable if the space is available to provide a separate facility (probably shared with pedestrians), located outside the roundabout.

Each situation should be assessed individually to arrive at the most appropriate solution.

There are a number of options when considering conflicts between cyclists negotiating roundabouts and not only buses, but other general traffic as well (see, eg, RTA, 2003, esp pp48-52).

References

RTA NSW (2003). *NSW Bicycle Guidelines*. Roads and Traffic Authority of NSW: Sydney, NSW.
www.rta.gov.au/trafficinformation/guidelines/documentregister/technicalmanuals.html

Australian Government (2002). *Disability Standards for Accessible Public Transport 2002*. Attorney General's Department: Canberra, ACT
http://www.ag.gov.au/www/rwpattach.nsf/viewasattachmentPersonal/5063DE01E16A6B97CA256C1D00070F9C/$file/2002distransport.pdf

Bus-Bike Interaction Within The Road Network

Information Note No 9 February 2005

AUSTROADS

FACILITY DESIGN: BUS STOP (NO CYCLE LANE)

Issue

One of the most regular and difficult interactions between buses and cyclists occurs at bus stops. When a bus is approaching a kerbside stop the driver may have to decide whether to overtake a cyclist and then pull to the kerb in front of it, or to slow down and wait for the cyclist to clear the bus stop. In the first instance, the cyclist then has to decide how to manoeuvre around the stopped bus. The options are usually either to overtake, by merging into the general traffic lane, or to wait for the bus to pull away. Alternatively, they may attempt to ride between the bus and the kerb, where a conflict often occurs with passengers boarding or alighting from the bus.

Recommended Approach

Bus stop location and design should take account of the extent to which buses stopping to pick up or drop off passengers will impede cyclists (and vice versa). Where the kerbside lane (whether a bus lane or a general traffic lane) is not wide enough for a cyclist to pass a bus safely, consideration should be given to localised widening of the lane to permit such passing (equivalent to a partial bus stop embayment) or full embayment of the bus stopping area. Embayment of the bus stop may also benefit bus operations where there is a mix of stopping and non-stopping services or where pick-up or drop-off of passengers is not required for a substantial proportion of buses because patronage generation from the adjoining area is low.

Where local cycle routes cross bus routes, particular attention should be paid to sight lines (for both bus drivers and for cyclists) and to signage to advise bus drivers of the likely presence of cyclists crossing. Wherever possible, bus stops should not be located where the presence of a bus would restrict the cyclist's ability to see motor vehicles that may overtake the stopped bus (ie on the upstream side of the intersection); alternatively, road treatment should preclude the passing of a stopped bus (eg a raised median, which may also serve as a staged crossing facility for cyclists and pedestrians).

Discussion

There are a few options for the design of bus stops, each of which can have a distinct effect on the passage of cyclists. There are also advantages and disadvantages for the buses.

a) Stopping at kerbside, within the running lane

- buses can pull away easily after stopping;
- maybe issues with parked cars, if allowed;
- cyclists must go around the outside of the stopped bus, or wait (as must general traffic);
- potential conflict if a bus and a cyclist are approaching a stop concurrently.

b) Bus embayments

- buses have to merge to rejoin traffic flow. This depends upon the goodwill of other drivers, despite the requirement to give way (see box, below);

Rule 77 of the [Australian Road Rules](#) states:

(1) *A driver driving on a length of road in a built-up area, in the left lane or left line of traffic, must give way to a bus in front of the driver if:*
(a) the bus has stopped, or is moving slowly, at the far left side of the road, on a shoulder of the road, or in a bus-stop bay; and
(b) the bus displays a give way to buses sign and the right direction indicator lights of the bus are operating; and

Give way to buses sign

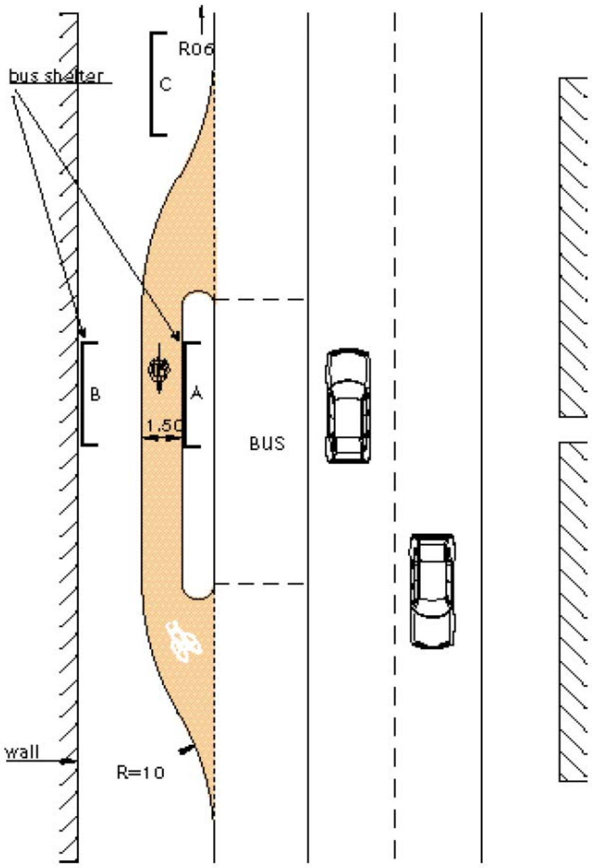
This sign is displayed on buses.

(c) the bus is about to enter or proceed in the lane or line of traffic in which the driver is driving.

- cycles can easily continue past the stopped bus (as can general traffic);
- potential conflict with cycles as buses enter or leave the embayment.

c) Bus boarders

- bus can pull away easily after stopping;
- cyclists must go around the outside of the stopped bus, or wait (as must general traffic);
- potential conflict if bus and cyclist are approaching stop concurrently;
- bicycle by-pass may be possible to the property side of the bus stop, even where there is no separate bike lane on the roadway.



Source: DTO (1997)

Cycle By-Pass with Bus Boarder and Continuing Cycle Lane

Photo: Glen Koorey

It is important that cycle by-passes are designed and constructed to appropriate standards, especially grades, curve radii, sight lines and the cyclist operating envelope. Both the examples above and below have furniture that restricts or intrudes into the cyclist's operating space and introduces unnecessary hazards.

Cycle By-Pass at Transit Stop

Where there is no separately defined cycle lane, none of the above choices are ideal, although the use of bus embayments may have the least effect on cyclists. Unfortunately this would probably be the solution least favoured by bus drivers. The lateral bus stop location decision is likely to be made more on the basis of whether or not parking is allowed adjacent the stop and the need for buses to maintain or be able to regain their place in the traffic stream, than due to consideration for bus/bike interaction.

Low floor buses with wheelchair ramps will need to be able to approach close to and parallel to the kerb for effective deployment of ramps to the kerb, which will be most facilitated by solutions that do not require lateral movement of the bus across the roadway.

Wood (1998) describes the main issues in the following terms:

- *Cyclists can be blocked by buses at stops, necessitating an overtaking manoeuvre. (Bus drivers may see the reverse of this, that cyclists cause them to have to approach stops more slowly than they otherwise would.)*
- *Where cyclists have to wait behind the bus or give way to passengers crossing their path, they are disadvantaged in comparison with general motor traffic, which is usually able to pass the bus and which they are supposedly being given a degree of priority over.*
- *The design of cycle lanes, pavements* (footpaths) *and bus stops traditionally cedes priority to cars and lorries, so that conflicts between buses, cyclists and pedestrians are accepted in order to avoid conflict with other traffic.*

The decision should be encouraged to also address cyclist safety and convenience issues (see Information Note 3, *Cycle Safety Audit*).

References

DTO (1997). *Provision of Cycling Facilities: National Manual for Urban Areas*. Dublin Transportation Office: Dublin, Ireland. http://www.dto.ie/publicdown.htm

Wood, Chris (1998). 'Bus Stop Design for Minimum Conflict'. *Transition*, No 5, October 1998. http://www.cilt.dialpipex.com/conflict.htm.

Bus-Bike Interaction Within The Road Network

Information Note No 10 February 2005

FACILITY DESIGN: CYCLE LANES AT BUS STOPS

Issue

The issue here is fundamentally the same as that for Guideline 9, Bus Stops (No Cycle Lane), but is exacerbated by the bus always being positioned further out from the kerb on the approach to the bus stop.

When a bus is approaching a kerbside stop the driver may have to decide whether to overtake a cyclist and then pull to the kerb in front of it, or to slow down and wait for the cyclist to clear the bus stop. In the first instance, the cyclist then has to decide how to manoeuvre around the stopped bus. The options are usually either to overtake, by merging into the general traffic lane, or to wait for the bus to pull away. Alternatively, they may attempt to ride between the bus and the kerb, where a conflict often occurs with passengers boarding or alighting from the bus.

Recommended Approach

Where a cycle lane lies between a bus lane and the kerb, the lane should be continuous across any bus stops, even though the bus will need to pull to the kerb to pick up or discharge passengers.

The road traffic laws generally allow a cyclist to leave a cycle lane to pass an obstruction, which would include a stopped bus. However, where a bus lane is adjacent, this requires that cyclists be legally allowed to ride in a bus lane (see Information Note 1, Bus Lane Regulations). It is also important that bus drivers pull close to and parallel to the kerb at stops to ensure adequate passing space for a cyclist on the traffic side.

Where the frequency or duration of bus stopping and/or the number of cyclists are large, consideration should be given to:

- an embayed bus stop (behind the cycle lane);
- partial embayment of the bus stop; or
- a cycle by-pass – a short section of off-road path to the property side of the bus stop.

In the case of the cycle by-pass, it is essential to ensure that design, construction and lateral clearances are compatible with the requirements for high-standard bicycle facilities, especially with reference to grades, curve radii, sight lines and the cyclist operating envelope.

Discussion

There are a number of options for reducing conflict where cycle lanes pass bus stops. Any proposal must also consider the access needs of people with disabilities to ensure that passenger access and egress meets the requirements of the Disability Discrimination Act, 1992, and the Accessible Public Transport Standards (www.rta.gov.au/trafficinformation/guidelines/documentregister/technicalmanuals.html).

The main options worthy of consideration are:-

a) Give way requirement for cyclists, (where the bus stop is on the road side of the cycle lane)

- passengers can board/leave the bus safely;
- no conflict between bus and cycle;
- similar to existing requirement for all vehicles with respect to trams in Melbourne;
- may require localised raising of the cycle lane to kerb level to provide for disability access.

PHOTO: Randers Amtsavis

b) Cycle lane passes outside of the stopped bus

- Conflict when bus crosses cycle lane on entering or leaving the bus stop;
- Generally, only feasible with embayed bus stop;
- May increase difficulty for bus re-entering the traffic lane if no dedicated bus lane.

Bus Bays can allow continuation of cycle lane at bus stops

c) Bike lane by-passes bus stop on property side:

- No conflict between bus and bike;
- No conflict between bike and boarding passengers;
- Possible conflict with alighting passengers who will all need to cross the path at the same time.

This option is best suited to 'inbound' bus stops, where the majority of passengers are boarding and therefore will not all need to cross the cycle by-pass together. At 'outbound' stops, bus dwell times will also be shorter as passengers alight faster than they board.

A variation on this includes a 'bus-boarder' kerb extension to minimise any problems for the bus re-entering the traffic stream (below). The extent to which this can be achieved, however, is limited by the need to provide for a continuous lane for cyclists to use when no bus is at the stop. Design of such a bus boarder should also ensure that there is not room for a motor vehicle to pass to the right of the bus within the kerbside lane.

Cycle By-Pass with Bus Boarder and Continuing Cycle Lane

It is important that cycle by-passes are designed and constructed to appropriate standards, especially grades, curve radii, sight lines and the cyclist operating envelope. Both the examples above and below have furniture that may restrict or intrude into the cyclist's operating space and introduce unnecessary hazards.

All such facilities should be designed in accordance with the specifications in Austroads (1999), including:

- *A lateral clearance of 1.0 metres (0.5 metres minimum) should be provided between the edge of any path for cycling and any obstacle which, if struck, may result in cyclists losing control or being injured* (Austroads, 1999, p72)

Cycle By-Pass with Potential Lateral impediments

In the case of a separately marked cycle lane, the position of the cyclist in the roadway is more clearly prescribed prior to reaching a bus stop location. This leads to the necessity for continued clarity as to the courses of action open to the cyclist. It is not good enough to simply stop the cycle lane short of each bus stop, and leave the cyclists to fend for themselves. Nor should the cycle lane just continue through, inviting the bus to straddle it in order to approach the kerbside stops.

Where a cycle lane continues through between the bus stop and the footpath, it may be necessary to raise the level of the lane to provide level access for passengers with disabilities between the kerb/waiting area and the bus. This may be seen, as it applies to <u>all</u> traffic, in the case of the 'Easy Access Stops' developed for the 109 Tram route extension in Melbourne.

(http://www.doi.vic.gov.au/doi/doielect.nsf/2a6bd98dee287482ca256915001cff0c/33ef8f9145b38066ca256c850015ec61/$FILE/Fact%20Sheet%203%20Box%20Hil.pdf).

Traffic By-Pass with Raised Platform

Wood (1998) sets out the issues in the following terms:

- *Cyclists can be blocked by buses at stops, necessitating an overtaking manoeuvre. (Bus drivers may see the reverse of this, that cyclists cause them to have to approach stops more slowly than they otherwise would.) Near-side cycle lanes effectively or actually disappear at bus stops.*
- *Where cyclists have to wait behind the bus or give way to passengers crossing their path, they are disadvantaged in comparison with general motor traffic, which is usually able to pass the bus and which they are supposedly being given a degree of priority over.*
- *The design of cycle lanes, pavements* (footpaths) *and bus stops traditionally cedes priority to cars and lorries, so that conflicts between buses, cyclists and pedestrians are accepted in order to avoid conflict with other traffic.*

Reference

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

Wood, Chris (1998). 'Bus Stop Design for Minimum Conflict'. *Transition*, No 5, October 1998. http://www.cilt.dialpipex.com/conflict.htm

FACILITY DESIGN: BUS SHELTERS IMPEDING SHARED PATHS

Issue

Bus shelters that intrude on the travel space of cyclists on shared paths, either directly (ie encroaching on the path itself) or indirectly (reducing lateral clearances) will reduce the safety, convenience and comfort of the facility for cyclists. Bus shelters are increasingly used for commercial advertising, which requires exposure to passing traffic, rather than having as its primary function serving the needs of bus users.

Even where no shelter is present, bus stop furniture (posts, seats, etc) may intrude on the travel space for cyclists.

Recommended Approach

As a matter of principle, bus shelters and other associated bus stop furniture should not intrude upon shared paths, either directly or indirectly.

Alternative locations should be sought for bus shelters in close proximity to shared paths. Where bus shelters are being considered in proximity to a shared path, the bus proponent should have the responsibility to ensure that the appropriate level of service is maintained for users of the path, either on the same or alternative alignment.

Where no alternative suitable location is available for either the bus stop furniture or the path, any intrusions into the path should be clearly delineated with line-marking and the bus stop furniture itself should be treated to maximise visibility to path users.

The same criteria should be applied to footpaths, since most jurisdictions allow cycling on footpaths at least by children up to the age of 13 and, in some cases by adults, unless cycling on the path is specifically prohibited by sign.

Discussion

It is often the case that bus stops and shelters are provided by a different authority to that responsible for the road infrastructure and the actual bus service. Location and design of bus shelters has an impact not only on functionality for bus passengers, but also for cyclists who may be legal users of adjacent footpaths or shared paths.

A bus shelter or other bus stop furniture that intrudes upon a shared path may well compromise the path standards to the extent that it no longer qualifies as a shared path.

Bus Shelter Impeding Shared Path

The location pictured below originally had a bus shelter that intruded significantly into the path (this was identified during a road safety audit); this was removed, but the replacement indicator of a bus stop (the orange post) and the seat also take a significant part of the path width out of use either directly (as in the case of the orange post) or for lateral clearances from the objects (post and seat).

Bus Stop Furniture Impeding Shared Path

The objective should be to provide a solution that meets the needs of all users – cyclists, pedestrians and bus users (who are also pedestrians to and from the bus stop). In the above case, the shelter could easily have been moved back from the road, into the area between the path and the fence, but the 'driver' for having a shelter there was probably to display advertising rather than to provide passenger comfort – setting the shelter back this far would diminish the effectiveness of the advertising.

The same principle applies for ordinary footpaths where cyclists are legal users of those facilities. This varies between States and Territories, but all jurisdictions now allow at least primary school age children to ride on footpaths.

There are many examples of bus shelters being sited in ways that impede access, both physically and visually, for pedestrians and other path users, including cyclists and people with disabilities.

In part, this is a result of the promotion of such shelters, on busy roads, as a means of raising advertising revenue to assist with the cost of provision and maintenance

Bus stop furniture, such as bus shelters, should be placed with due regard to the safety and convenience of all path users, and the relevant authorities should take steps to ensure that this is the case.

Bus-Bike Interaction Within The Road Network

Information Note No 12 February 2005

FACILITY DESIGN: LOCAL AREA TRAFFIC MANAGEMENT

Issue

Local Area Traffic Management (LATM) involves modifications to the structure, layout or design of local streets, with the primary objective of reducing the adverse amenity impacts of car traffic in residential areas. Such modifications can have adverse impacts on the suitability of the street for bicycle and bus use unless facilities are appropriately designed.

Recommended Approach

Where the presence or existence of LATM treatments might adversely affect the interaction between buses and bicycles, consideration should be given either to selecting a more suitable device or adapting the device to minimise the effect.

When a potential problem is identified, consideration must be given to the needs of both buses and cyclists. Some vertical displacement devices can easily be designed to enable bicycles to bypass the treatment. This may also be the case with horizontal displacement devices, such as slow points. It is however of paramount importance that cyclists remain visible to other traffic as they pass through the treatment, and that both modes can merge safely afterwards.

Where only buses, but not other vehicles, are allowed access between parts of the local street system, the facility should be designed to allow safe passage of bicycles and pedestrians. This can also be a useful approach in town and city centres, where general traffic is excluded from some road links.

Discussion

In general, LATM or ‘traffic calming’ includes all measures taken to reduce the speed of vehicles, often to achieve a 30km/h (20 mph) zone. It includes a range of methods such as the use of different surface materials (for example paving stones instead of macadam), road narrowing, humps, chicanes, roundabouts, speed cushions, raised junctions, or any combination of them. In general, traffic calming measures can be categorised into ‘vertical’ or ‘horizontal’ obstacles.

The introduction or presence of LATM treatments will generally have limited effect on the interaction between buses and cycles. Each application should be considered on its own merits, and any potential problems should be picked up by the usual safety audit processes (see Information Note 3, *Cycle Audit*). Further information is available in Guide to Traffic Engineering Practice, Part 10, Local Area Traffic Management (Austroads, 2004).

It is also important that LATM measures do not result in impediments for buses. The requirements for accommodating buses in LATM will be outlined in the forthcoming Guide to traffic Engineering Practice, Part 16, On-Road Public Transport.

LATM can be used to provide access for buses, from one part of the local street system to another, but not for other motor vehicles. Sometimes called bus gates or bus sluices, these can also provide opportunities for enhancing cycle and pedestrian access, but to do so must be appropriately designed. In the picture, below, for example, the bus portion would be hazardous for cyclists and pedestrians because of the narrow travel surface and the conflict with buses using the same space, so a parallel access has been provided.

Bus Gate Also Provides Access for Cyclists and Pedestrians

Source: Road Directorate (2000)

Preferential bus access is also a useful approach where general traffic is excluded from some road links in town and city centres. Whilst these usually allow for pedestrian access (on the pre-existing footpaths), cyclists may be excluded or not considered. Such links are usually quite short and, in many cases, cycle access will not impede buses to any great extent (see picture overleaf).

Central City Local Area Traffic Management: Cyclist Access to Bus Priority (Hobart, Tasmania)

References

Austroads (2004). *Local Area Traffic Management*. Guide to Traffic Engineering Practice, Part 10. Austroads: Sydney, NSW.

Road Directorate (2000). *Collection of Cycle Concepts*. Road Directorate: Copenhagen, Denmark.
http://www.vd.dk/wimpdoc.asp?page=document&objno=17291

Bus-Bike Interaction Within The Road Network

Information Note No 13 February 2005

FACILITY DESIGN: TRAMS IN KERBSIDE LANES

Issue

Whilst not specifically an interaction between ***Buses*** *and cycles, in a similar vein, Tram tracks in the kerbside lane are incompatible with the safe and convenient operation of bicycles.*

Tram lines in the roadway are a hazard for cyclists where they cannot be crossed at something approaching a right-angle. Trams in the kerbside lane would leave only a narrow piece of road (600-750mm) between the track and the kerb, effectively precluding cyclists from moving out of this area, either to pass a tram (or other vehicle) or to make a right-hand turn.

Recommended Approach

Where kerbside tram operation is being considered, a separate cycle facility should be included as an integral part of the project. Such facilities should not reduce the level of service to cyclists (for example, through loss of priority at intersecting streets or substantial detours away from the direct route).

Where trams operate away from the kerb but the kerb is projected out to the tramline at stops, similar treatments to those for projecting bus stops should be considered (see Information Note 9, *Bus Stop (No Cycle Lane)* and Information Note 10, *Cycle Lanes at Bus Stops*).

Discussion

Tram or light rail services in Australia generally operate either in the centre of the road or in a dedicated right-of-way, which may itself be in the median of a roadway. However, there are suggestions that trams might operate in the kerbside lane, which has some benefits in terms of passenger access and enhancing right-turn opportunities for general traffic. Disbenefits would include the potential for trams being impeded by broken-down or illegally-parked vehicles and the loss of kerbside motor vehicle parking opportunities, as well as the reduction in safety and convenience for cyclists.

A specific case of this issue has arisen with the trial in Melbourne of tram stops that project out to the tram line (see below).

The specification in CROW (1993, pp114/5) appears to preclude trams in kerbside lanes. *If at all possible, a mixed profile with tram, car and bicycle should be avoided on through cycle routes. Where this is impossible, the following premises of design apply:*

- *Cyclists must be able to ride to the left of the tram*
- *Motor vehicle volume should be low, so that cyclists have more chance to avoid skidding across the rails (room for manoeuvre)*
- *Preferably a stopping ban should be applied on the road section*
- *Where tram tracks or cycle routes bend, the cyclist must be able to cross the rails at a minimum angle of 45º.*

Tram Stops with Cycle By-Pass

This is a result of both direct and indirect dangers for cyclists:

- Directly, it is dangerous for cyclists to cross rails at an acute angle, especially in wet weather.
- Indirectly –
  - o Cyclists sometimes need to pay so much attention to avoid falling that they miss other hazards

- o Cyclists are not always able to choose a safe path, for example at sufficient distance from parked cars
- o Tram rails limit the freedom of movement in emergency manoeuvres.

Tram tracks in the kerbside lane are incompatible with the safe and convenient operation of bicycles as they leave only a narrow operating space (600-750mm, which is substantially less than the operating width stated in bicycle design guidelines (Austroads, 1999, Figure 3-1) and would place the cycle wheel very close to the track). Cyclists would be unable to move out of the immediate kerbside area, as the trajectory across the track would be very acute and lead to the cycle wheel falling into the depressed area of the track.

Conversely, trams would be unable to pass a cyclist unless additional width is provided, as unlike buses, they cannot change lateral position in the roadway to do so.

In practice, it is very difficult to avoid creating safety problems for cyclists with on-street tram or light rail running. The problems are exacerbated with kerbside tram operation.

Factors to take into account include:

- the width of the streets with tram tracks;
- topography; and
- the extent to which attractive alternative routes for cyclists wishing to avoid the tram tracks are available and regarded as an adequate substitute taking into account their relative length, topography, surfaces, social safety and how far they serve destinations that different cyclists want to reach (McClintock and Morris, 2003).

References

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

CROW (1993). *Sign Up for the Bike: Design manual for a cycle-friendly infrastructure.* Centre for Research and Contract Standardisation in Civil and Traffic Engineering: The Netherlands.

McClintock, H and Morris, D (2003). 'Integration of Cycling and Light Rapid Transit: Realising the Potential'. *World Transport Policy and Practice, 9 (3), pp9-14*. http://www.eco-logica.co.uk/WTPP09.3.pdf

AUSTROADS

FACILITY DESIGN ON HILLS

Issue

Other things being equal, cyclists will travel more slowly on uphill grades and be more likely to be encountered by a bus seeking to pass. Cyclists will be less likely to be impeded by a bus.

Conversely, downhill grades will decrease the frequency with which a bus encounters a cyclist and increase the frequency with which a cyclist may be impeded by a bus (usually at a bus stop).

Recommended Approach

When designing bus and/or cycle networks or specific facilities (eg bus and/or cycle lanes) on gradients, one should take into consideration the effect of those gradients on the speed differential between these modes.

Where there is opportunity for additional bus/bicycle space in only one direction, that space should be provided in the uphill direction unless the specific circumstances indicate otherwise.

Gradient should also be allowed for in setting traffic signal phasing, including bus priority signals, especially where cyclists or other vehicles make hook turns (see Information Note 15, *Hook Turns*).

Discussion

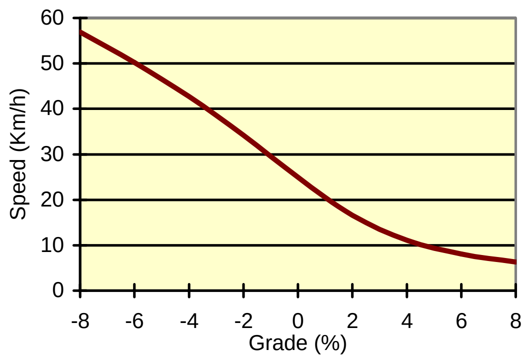
Gradients, particularly steeper gradients or long sections of gradient, can have substantial impact on the speed of cyclists and the speed differential between buses and bicycles. The interaction between bicycles and buses using the same facility, whether it be a bus lane or a general traffic lane, will be greater at slower cycle speeds – and will certainly be perceived that way by bus drivers.

The impact of gradient on speed will depend upon circumstances, especially the length of grade.

For a short hill, cyclists may increase their effort to maintain speed.

On a longer uphill grade, performance will tend to fall back to the speed achievable with the level of effort at which the cyclist normally operates and feels comfortable. For longer grades, the assumption of constant effort allows the effect on cyclist speed to be estimated, for example http://www.kreuzotter.de/english/espeed.htm, which is a calculator that allows user-specification of a range of variables, including gradient. For a 175cm tall cyclist weighing 80kg, riding a racing bike with medium width high pressure tyres, expending sufficient energy to maintain 25km/h on the level with no head or tail wind, the following speeds result from varying gradient. A 2 per cent gradient uphill, for example, reduces the cyclist speed from 25km/h on the flat to 17km/h, increasing the time taken to travel a given piece of road by around 50%.

Impact of Gradient on Cyclist Speed



Gradient can make a significant difference to the length of time a cyclist takes to cross an intersection, especially in the case of a cyclist making a hook turn, who will be decelerating, rather than accelerating or travelling at constant speed, through the intersection. Traffic signal phasing should provide sufficient time for a cyclist to clear an intersection before intersecting traffic is given a green light. This is particularly important where bus priority signals are in operation on the intersecting road, as the bus driver may be unaware of a cyclist still in the intersection as the bus has been given a clear signal of priority.

Bus-Bike Interaction Within The Road Network

Information Note No 15 February 2005

AUSTROADS

TRAFFIC MANAGEMENT: HOOK TURNS

Issue

Cyclists may take longer to cross an intersection to the 'hook-turn' point at the left of the roadway and may not arrive until after the lights for turning/intersecting traffic have turned green.

Where bus priority signals are in operation on the intersecting road, a bus driver may be unaware of a cyclist still in the intersection as the bus has been given a clear signal of priority.

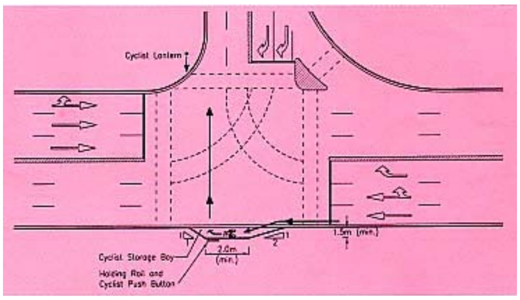
Recommended Approach

<u>Where all vehicles are *required* to make a hook turn</u>:

- Traffic signal phasings should ensure that a cyclist legally passing a signal on entry to the intersection, and proceeding straight through, is able to clear the intersection before the 'hook-turning' or intersecting traffic receives a green light.
- Consideration should be given to exempting buses from the requirement to make a hook turn by allowing them access to the tram tracks at such intersections.
- In general terms, minimise the requirement for buses to make right turns in congested areas, as such turns are always a potential source of delay and unreliability for bus operators.

<u>Where only a cyclist is *allowed* to make a hook turn</u>:

- At a signalised intersection, signal phasings should ensure that a cyclist legally passing a signal on entry to the intersection:
  - o in the case of a cyclist making a hook turn, is able to reach the turn point, where he/she will be clearly visible to the drivers of intersecting vehicles, before the intersecting traffic receives a green light. This phasing will need to take into account the fact that the cyclist will be decelerating, rather than accelerating or travelling at constant speed, through the intersection; and
  - o in the case of a cyclist proceeding straight through the intersection, is able to clear the intersection before the intersecting traffic receives a green light.
- Signal phasing must also avoid situations where cyclists cannot legally proceed after making the first stage of a hook turn and impede or are in danger from a legal manoeuvre for other traffic (eg a dedicated left-turn phase from the intersecting road).
- At an unsignalised intersection, consideration should be given to provision of a cyclist refuge, outside the normal traffic areas where a cyclist can wait for a safe and convenient gap in the traffic to make the turn while not impeding left-turning traffic from the intersecting road. However, where conflicting traffic movements are heavy, some means should be provided for cyclists to create a gap in the traffic flow to safely cross the road and complete the right turn – for example, a demand-actuated cycle or cycle/pedestrian phase in the signals (see Austroads, 1999, Figure 5-17).



Source: Austroads (1999, p57)

Discussion

Motor Vehicle Hook Turn

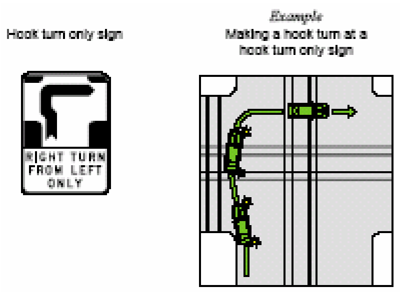
A 'hook turn' is a right-turn made from the left side of the road and is only legal for motor vehicles in parts of the City of Melbourne, where right turning traffic would potentially impede a high-volume tram route. Right-turning vehicles are required to move to the left side of the intersection, in front of intersecting traffic, and may move off only when the traffic signal for the intersecting traffic turns green.

The danger to the through cyclist is from both turning traffic, with drivers focussing on the signal to their right rather than on a small vehicle still approaching from behind, and from intersecting traffic.

This is not solely a bus-bike interaction issue, but may be exacerbated in the case of a bus making a hook turn, as the bus driver may feel greater pressure to clear the intersecting road when the bus may be blocking multiple traffic lanes.

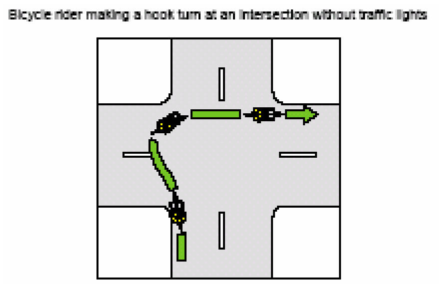
In addition, where bus priority signals are in operation on the intersecting road, a bus driver may be unaware of a cyclist still in the intersection as the bus has been given a clear signal of priority.

Traffic signal phasing should ensure that cyclists have sufficient time to clear the intersection, before intersecting or right-turning traffic is given a green signal.



Cyclist Hook Turn

The Australian Road Rules (Rule 35) make provision for cyclists to make a hook turn at any intersection, whether signalised or not, unless specifically prohibited by sign.



In undertaking such a manoeuvre, the cyclist is left vulnerable to intersecting and left-turning traffic from the side road. Partly for this reason, GTEP Part 14 (Austroads, 1999) specifies the setting back of vehicle stop lines and pedestrian crossings, at signalised intersections, to provide a clear area for the cyclist to stop and turn in advance of any other activity.

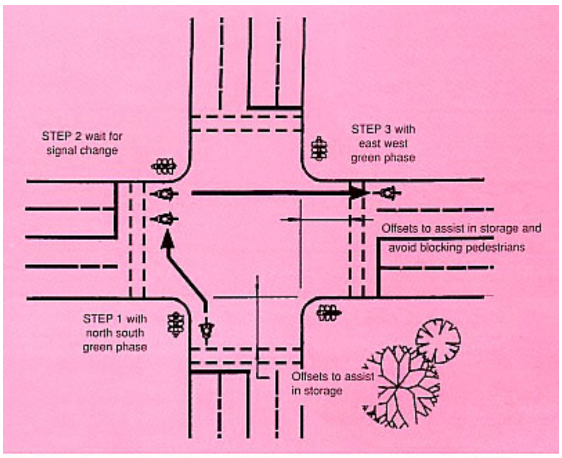
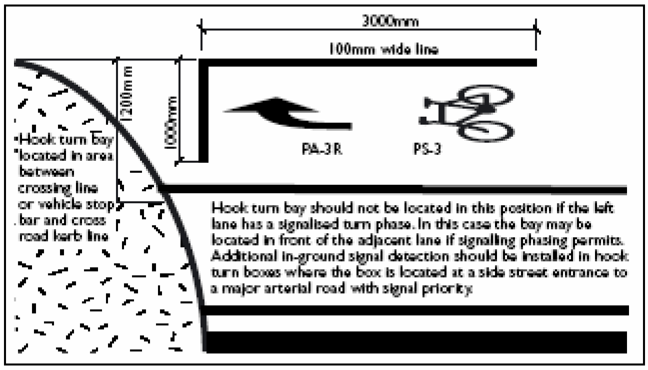


Figure 5-16: Hook Turns

A hook turn box may be marked on the roadway to enhance the convenience and safety for all road users where hook turns by cyclists are common. This box should be no longer than 3.0m and 1.0m wide. It should be located in a 2.5m wide area immediately in front of the pedestrian crossing area and not protrude into the adjacent crossroad kerbside travel lane. Hook turn boxes should always be placed so that they do not conflict with left turn signal phasing. Additional signal detection should be considered where hook turn boxes are placed at side street entrances to major arterial roads.



Source: RTA (2003)

In cases where cyclist hook turns cannot be carried out safely, for example because of the complexity of the intersection, consideration should be given to erecting a 'no hook turns' sign (Australian Road Rules, Rule 36), subject to a safer alternative being available for cyclists.

References

Austroads (1999). *Guide to Traffic Engineering Practice, Part 14: Bicycles*. Austroads: Sydney, NSW.

RTA NSW (2003). *NSW Bicycle Guidelines*. Roads and Traffic Authority of NSW: Sydney, NSW.
www.rta.gov.au/trafficinformation/guidelines/documentregister/technicalmanuals.html

CYCLE USE OF 'B' BUS PRIORITY LIGHTS

Issue

Bus priority lights are usually approached by a bus lane (which may be used by cyclists), but regulations state that only buses can move when the signal is illuminated. Bus priority lights can be used to authorise movements not permitted to other vehicles, as well as to give priority timing.

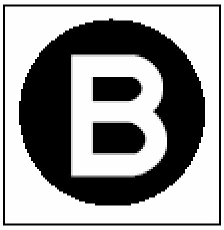
Recommended Approach

Eligibility to use the 'B' bus priority lights should be consistent with the eligibility to use the approaching lane, rather than having separate and potentially confusing rules.

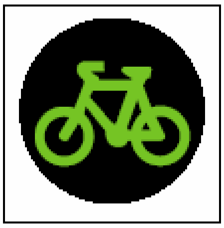
Under the current road traffic rules, cyclists are not allowed to make use of 'B' bus priority lights, but an additional cycle lantern, operating on the same phasing, could be installed. Where cyclists are allowed, by this, access to the signal priority, care must be taken to ensure that detectors are able to respond to a bicycle as well as a bus.

Where the bus priority light authorises movements that may be unsafe, inappropriate or unnecessary for cyclists (eg access to a bus station or depot), advance warning and safe/appropriate transition to an alternative facility (cycle lane or shared path) shall be clearly provided and signed. Merging of cycle traffic with the adjacent general traffic lane is not encouraged (see Information Note 18, *Bus Lane Regulations*), especially in the vicinity of an intersection.

Discussion



The 'B' bus priority may be used to give priority to buses at signalised intersections. In most instances, even if the approach to the signals is not designated as a bus lane the onward movement authorised by the signal will only be available to authorised users of the facility beyond the signals. In some cases (eg entry to bus stations – see Information Note 6, *Bus Station Entry/Exit*), the only authorised movement will be for buses. In others, there may be a continuing bus lane that cyclists (or other users, such as taxis) are allowed to use.



There is no provision, in the Australian Road Rules, for any road user other than the driver of a bus to access the priority granted by such a signal. However, where the continuing movement is safe and appropriate for cyclists, it would be possible to add a cycle lantern to the signal array.

Where the onward movement is restricted to buses only, this is appropriate, but measures need to be put in place to ensure that only buses can legally approach the signal and that an adequate alternative is available for cyclists. In South Australia, this has been addressed by separation at the signals. NSW practice is to have Bus-Only lanes on the approach to B-signals.

Separation of Cyclists and Buses at 'B' –Priority Lights

Where the onward movement is available to users other than buses, the signal needs to operate and be interpreted in similar terms. This includes issues relating to eligibility to use the facility on the approach to the signals and ensuring that the signal detectors will respond to all legitimate users, including cyclists. This may preclude the use of active bus-mounted transponders to trigger the signal. Failure to ensure this will result in buses being held up unnecessarily by cyclists.

In Queensland, consideration is being given to allowing cyclists to access the 'B'-light priority. This will require the corresponding ability to exclude cyclists where the continuing movement is not available to cyclists.

NEW BUS FACILITIES

Issue

New, dedicated, bus facilities in exclusive rights of way, provide opportunities for creating new cycle and pedestrian facilities and movement opportunities along the same alignment. As well as enhancing the route options available to cyclists and pedestrians, such facilities also improve the accessibility of bus stops and stations along the route, potentially increasing bus patronage especially if bicycle parking is also provided (see Information Note 25, Bicycle Storage Facilities) and enhancing the accessibility of locations along the route.

However, such facilities may also increase severance and reduce the convenience of cycling if adequate crossing opportunities are not provided.

Recommended Approach

Wherever possible, new dedicated bus or transit corridors should be planned, designed and constructed as multi-modal 'green transport corridors', with specific provision for cycle movement along and across the primary bus facility.

Because buses will be travelling at a relatively high speed, particular consideration should be given to:

- separation of bicycle facilities from the busway/ transitway;
- traffic control (especially on the crossing bicycle route) and sight lines (for both bus driver and cyclist) at cyclist crossing points.
- Cyclist and pedestrian connections to nearby development and to bus stops/stations (see also Information Note 25, *Bicycle Storage Facilities*).

Discussion

Sydney and Brisbane are developing networks of unguided busways that are also integrated with other modes and with land use.

The Western Sydney Transitway Network consists of a bus priority network centred around a number of exclusive bus roadways that are being progressively delivered across Sydney. The first is in operation between Liverpool and Parramatta,

There are three basic levels of bus access associated with the T-way corridors:

- *Trunk services* that run over the full length of the T-way stopping at all or key stations only;
- *Integrated express services* (regional or express feeders) that commence their run remote from the T-way, picking up passengers from surrounding suburbs and then joining the T-way to take advantage of the rapid running through to a terminus or to a departure point giving access to a remote destination.
- *Local feeder services* bring passengers from surrounding areas to a T-way station where passengers will alight and change to a T-way service.

The Parramatta Transitway has been planned and constructed with bicycle facilities parallel to the busway, as well as allowing cyclists to cross at specified points.

Parramatta Transitway with Associated Bicycle Facility

Because buses will be travelling at a relatively high speed, particular consideration should be given to the separation of bicycle facilities from the busway/ transitway and to traffic control (especially on the crossing bicycle route) and sight lines (for both bus driver and cyclist) at cyclist crossing points.

Such crossing points must be appropriately connected to nearby development and to bus stop/station locations along the busway/transitway.

Dedicated bus facilities should include good cycle and pedestrian connections to nearby development

Source: Hart (2003)

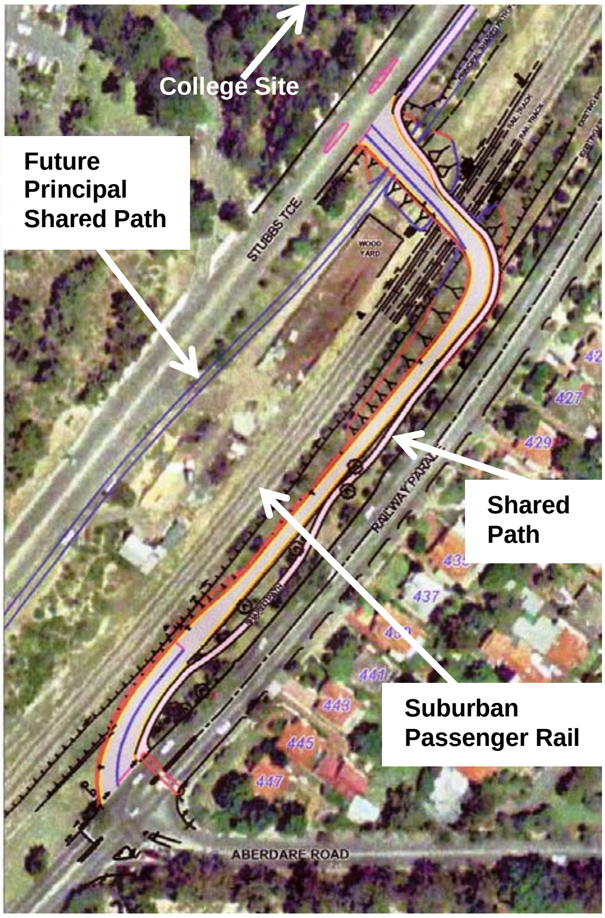
The SE Busway in Brisbane is primarily a line-haul facility operating in a freeway reserve. As such, it does not have dedicated bicycle facilities associated with it. However, the City of Brisbane Transport Plan, 2002-2016 (Brisbane, 2002) states that one of its strategies for achieving 'more clean and green personal transport' is: *Ensuring that pedestrian and cyclist planning is integrated with all transport initiatives early in project and policy development* [to] *maximise intermodal options ...* [including] *... providing shared bicycle/HOV facilities and shared bus/bicycle facilities on new bus/HOV projects*.

Bus-only infrastructure, including the Sydney Transitways, are often planned and designed in conjunction with other modes, partly to enhance access to the bus system but also to provide additional travel opportunities, as in the case of the Green Bridge to the University of Queensland. The Brisbane City Transport Action Plan 2002-2016 (Brisbane, 2002) specifically identifies incorporation of *dedicated bicycle and pedestrian facilities on the proposed Green Bridge from the University of Queensland to Dutton Park <u>and on any future green bridge proposals such as Kangaroo Point to Edward St</u>* [emphasis added].

Brisbane's Green Bridge will include cycle and pedestrian facilities as well as a busway

On a smaller scale, provision of dedicated bus access across a railway, to serve a newly-established 'super-college' in the western suburbs of Perth, included a shared path for pedestrians and cyclists. This both connects to and complements the ongoing establishment of Principal Shared Paths along the suburban rail lines in Perth, as part of the *Perth Bicycle Network Plan*

Bus and Shared Path Bridge for New 'Super College' (Shenton Park, Perth, Western Australia)



References

Brisbane (2002). *Transport Plan for Brisbane 2002-2016*. Brisbane City Council: Brisbane, QLD. http://www.brisbane.qld.gov.au/BCC:STANDARD:1343068582:pp=PC_66,pc=PC_73

Hart, J (2003). 'Steering the Development Control Process to Support Public Transport'. *Proc 2003 AITPM National Conference*: Sydney, NSW.

Bus-Bike Interaction Within The Road Network

Information Note No 18 February 2005

BUS LANE REGULATIONS

Issue

Potential conflicts between bicycles and other vehicles are likely to be less in bus lanes than in adjacent general traffic lanes. However, cyclists operate more slowly than buses and may delay buses in a priority facility. There may not be safe and convenient alternative routes for cyclists.

Recommended Approach

Cycle and bus stakeholders should work together to maximise the level of provision for the two modes collectively. This may be achieved through network planning (see Information Note 1, *Network Planning*) as well as more specific facility planning and design.

Wherever possible, bus lanes should provide sufficient width for safe and convenient sharing of the lane by buses and bikes (see Information Note 4, *Shared Bus-Bike Lanes*). Even where sufficient width cannot be provided, cyclists should be allowed in kerbside bus lanes unless there is a substantial reason to exclude them. Such reasons might include:

- the bus lane only serving a bus facility (depot/bus station) or being the immediate approach to a bus priority signal that is unsuitable for cyclist priority (see Information Note 16, *B-Priority Lights*); or
- the specific circumstances (for example, numbers of cyclists and buses, impact of grades on cyclist speeds) demonstrating a substantial loss of benefits from bus priority if cyclists were to use the bus lane.

If it is proposed to exclude cyclists from a kerbside bus lane, it should be the responsibility of the proponent of the bus lane to ensure that alternative provision is made for cyclists, either in the same roadway (eg with a marked cycle lane) or on a convenient alternative route. The cost of providing or upgrading and maintaining this alternative for cyclists, including signage and other information, should be incorporated as part of the cost of the bus lane.

To avoid confusion (amongst cyclists and bus drivers), all bus lanes should be signed to clearly state whether bicycles are allowed in the lane or not. Consideration should be given to the use of bicycle logos stencilled on the roadway to provide a more visible indication of cyclists' status.

Discussion

Cyclists, bus operators and bus passengers all have an interest in the reallocation of road space away from the private motor vehicle. Competition for this scarce resource may not lead to the best outcome for all stakeholders. For example, exclusion of cyclists from bus lanes may make it more difficult to get bus lanes approved than if the lanes were to be joint facilities, as well as directly disadvantaging cyclists.

Despite all of the advertisements for faster bus travel showing smiling bus drivers, buses get stuck in traffic jams at peak travel times. Only after bus lanes are installed do the speeds increase in some segments -- but often to the disadvantage of bicyclists. Usually, there is no place for bike lanes where bus lanes are provided. The solution can be to open the bus lane to bicycle traffic as well, using the supplementary sign "Fahrrad frei" (open to bicyclists).

If you take a couple of tips to heart, you can take good advantage of this development. Bicyclists must ride as far left as possible, in order not to delay the buses. Overtake carefully at bus stops, paying special attention to motor traffic and crossing pedestrians.

Source: Allen (2004)

Where there is no physical or visual (eg separate marked cycle lane) separation of bus and bicycle facilities, the general practice in Australia and overseas is to allow bicycles to use a bus lane. Western Australia appears to be a sole exception in Australia, with its current practice at odds with that adopted either formally (through regulation) or informally (through the way in which regulations are applied) in other Australia jurisdictions and overseas (see page 3 of this Guideline for an outline of practice in individual jurisdictions).

The implicit justification for allowing cyclists to use kerbside bus lanes is that cyclists are safer in a kerbside lane with relatively few vehicles compared to the adjacent traffic lane, even where legal users of the bus lane may include taxis, emergency vehicles and motorcycles. In addition, the cyclist adjacent to the kerb has a potential 'escape route' (onto the verge or footpath) in the event of conflict with another road user.

In the absence of an adequate alternative route, cyclists will continue to use roads on which a bus lane has been installed, even if they are not legally allowed to do so. This is likely to be the worst of all worlds as there will still be the (real and/or perceived) negative impacts on buses and cyclist safety will be compromised as legitimate users of the bus lane will regard cyclists as having no business being there.

Legal sharing of a wide kerbside bus lane represents a win-win situation, as users are less likely to impede each other and each can travel faster and more safely and conveniently than when mixed with general traffic.

Legal sharing of a bus lane that is not wide enough to allow buses and bikes to pass each other within the lane should represent a sharing of benefits, with both groups of users benefiting from the removal of general traffic from the lane. Buses and bikes may hold each other up at particular points, but each will, generally, travel faster than when mixed in with the general traffic.

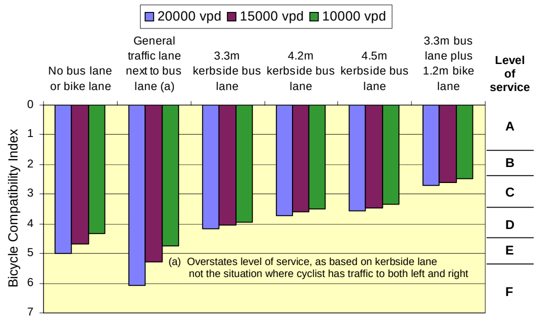
If analysis or monitoring shows that the aggregate benefits will be substantially reduced by such sharing, consideration should be given to the improvement or development of alternative route(s) for either cyclists or buses. It should not automatically be the case that the alternative route should be for cyclists, as there might be circumstances (for example, where the main bus passenger demand is through the area rather than having origin or destination in the area) where opportunity exists to establish an even higher standard facility (eg segregated busway) for services to meet the major bus passenger demand.

The US Federal Highway Administration has developed a methodology for applying the conventional traffic level of service to bicycles (US FHWA, 1998). Whilst this model does not specifically reflect buses as a distinct element in the traffic stream, it can be used to reflect the impact of having only heavy vehicles in the kerbside lane – consequently, the outputs developed on this basis should be regarded as indicative rather than precise.

Subject to the above qualification, the Bicycle Compatibility Index clearly shows (Figure 1) that:

- The level of service for cyclists is substantially reduced if they are forced into the residual traffic lane after a kerbside lane is converted to a bus lane;
- Overall road traffic volume makes little difference to the cyclist level of service when operating within a bus lane or in a bike lane adjacent to a bus lane;
- Operating within a bus lane, rather than in general traffic, improves the cyclist level of service more than increasing the width of the bus lane; and
- Adding a 1.2-metre wide bike lane to a bus lane improves the cyclist level of service by more than adding the equivalent width to the bus lane.

Bicycle Level of Service by situation and traffic volume
(25 buses/peak hour)



Conversely, the larger the number of buses using the bus lane, the lower the level of service for cyclists, although the model indicates that, with the exception of variations to bus lane width, the impact of more buses is small relative to the improvement due to the bus lane or a bike lane adjacent to a bus lane. However, it should be recognised that increasing numbers of buses will significantly add to the potential for buses to be held up by cyclists.

Similarly, the higher the speed of motor vehicles in the kerbside lane, the lower the level of service for cyclists, although the impact is significantly lower for a bus lane, with relatively few vehicles, than for a general traffic lane with high traffic volumes.

In the United States, the Transportation Equity Act for the 21st Century (TEA-21) prohibits the Secretary of State for Transportation from *approving any project or taking any regulatory action that will result in the severance of an existing major route or have an adverse impact on the safety of non-motorised transportation traffic and light motorcycles, unless such project or regulatory action provides for a reasonable alternate route or such a route already exists*.

Non-Kerbside Bus Lanes

Where a bus lane is established away from the kerb, for example to allow for all-day operation in conjunction with off-peak car parking, it may not be possible to install either a cycle lane or a combined bicycle/car parking lane if there is insufficient roadway width. In such cases, it is imperative that cyclists are allowed to use the bus lane, if there is no other continuously-accessible 'path' available to them (see Information Note 5, *Separate Bus-Bike Lanes*).

Reference

Allen, John S (2004). *Bike and Bus*. John S Allen's Bicycle Facilities, Laws and Programs Pages. http://www.bikexprt.com/bikepol/facil/lanes/bikebus.htm

Current Practice in Australia

[Information believed correct at the time of publication. However, users should check with the relevant State authorities before acting on this information.]

- *New South Wales*

Many of the bus lanes are relatively narrow. As far as we are aware, if they are bus lanes, bicycles can use them. If they are *bus-only* lanes, then bicycles are not meant to use them. Even at a number of squeeze points where the bus lanes become very narrow, bicycles are still permitted to use the lane.

There are a couple of exceptions to bus lane use by bicycles, such as the bus lane on the Harbour Bridge - bicycles do not have access to the lane, but they have their own separate facility (west-side of the bridge, with pedestrians on the east-side of the bridge). Taxis, hire cars and motorcycles may use the bus lane on the bridge.

There are very few bus-only lanes. Typically they are short sections of lane that might lead into a bus interchange area (such as two short sections of bus access road into the bus station that is being planned at Parramatta Railway Station's Transport Interchange) or on the approach to 'B' bus priority signals.

Another example is an off-road bus way along ANZAC Parade - this is bus-only, but there is a parallel shared path, and the busway was there long before anyone thought of the concept of bus lanes (old tramway).

There is a bus-way along the M2 Motorway between Windsor Road and Beecroft Road - it is in the median of the motorway. Bicyclists use the shoulder of the motorway.

- *Victoria*

Victorian practice , in the limited locations where there are bus lanes, all of which so far operate for peak periods/ directions only, is to allow use by cyclists (by signing). Examples are:

- Hoddle Street southbound Eastern Freeway to Victoria Parade (70 kph limit) has a wide kerbside lane designated bus lane for am peak - cyclists permitted
- Johnston St Yarra river to b/w Wellington and Smith Streets (60 kph limit) has narrow kerbside lanes, both sides, designated bus lane for am and pm peaks respectively – cyclists permitted
- Victoria Parade westbound Clarendon St to Brunswick St., currently there are proposals to extend this from Clarendon to Powlett are on the basis of permitting cyclist use.

Queensland

There are no situations currently that we're aware of where bicycles are excluded from bus and transit lanes using signage even though this is allowed for in the legislation. Cyclists are excluded from dedicated busways, and also from the Main Roads transit lanes which are on the Pacific Motorway (note that cyclists are excluded from this motorway anyway by signage, and the transit lanes are on the middle lanes of the road, not the outside lanes, so they would be very unsuitable for cyclists).

Cycle use of Inner City bus facilities in Hobart, Tasmania

- *Western Australia*

Western Australia has adopted the Australian National Road Rules that exclude cyclists from a bus lane unless explicitly permitted by sign. Some bus lanes in Perth are in the centre of the roadway (eg on the Causeway entry to the Perth CBD) and operate more like busways than bus lanes. On the Causeway, there is a pre-existing shared path adjacent to the roadway that provides an alternative direct crossing of the river for cyclists at this point.

There are only a small number of kerbside bus lanes in Perth, none of which has been signed to allow use by cyclists. However, a trial will be undertaken in 2005 on Beaufort Street, Inglewood.

- *South Australia*

South Australia does not exclude cyclists from bus lanes based on the lane's width and in general allows bicycles to use bus lanes. There are only two cases where this is the exception:

- Cyclists are excluded from Bus Lanes where they are lanes on approaches to signalised intersections with the bus lane controlled by Bus Priority signals. In all of these cases we have an adjacent bicycle lane for cyclists to use and keep out of the way of through buses.
- There is one Bus Lane where cyclists are excluded. This lane is within the central median and is only used for AFL matches at the AAMI Stadium i.e. once every weekend in the football season. Cyclists have the use of a wide kerbside lane at all times.

- *Tasmania*

Tasmania has adopted the Australian Road Rules in this respect (ie same as Victoria and WA). No information to-date on actual practice, but the photographs overleaf clearly show permitted bicycle usage (along with taxis and motorcycles) of an inner city bus facility (which also provides car access to certain properties along its length, so not technically a bus-lane), which primarily provides bus access to the main (on-street) bus station but also provides a continuing through route south-north for cyclists, avoiding a substantial detour.

- *Australian Capital Territory*

The ACT drivers' guide to the road rules states that "there are several bus-only lanes in operation in the ACT". One of these is on Barry Drive (the main road between the Canberra City Centre and the major town centre of Belconnen). Cyclists are banned from this, and as there is no cycle lane, they are legally required to ride in unprotected space in the general traffic lanes on an 80kmh road with buses passing to their left and cars to the right.


NO
THROUGH
ROAD
METRO BUSES
& BICYCLES
EXCEPTED
KEEP
LEFT

Bus-Bike Interaction Within The Road Network

Information Note No 19 February 2005

AUSTROADS

CONTRACTUAL AND COMMERCIAL IMPERATIVES

Issue

Bus operators under contract to State government or operating under franchise arrangements may be subject to financial penalty for late running. Even without this, there is a commercial and customer service 'imperative' to avoid late-running wherever possible. Cyclists are seen as slow-moving and likely to hold-up buses, especially where there is little requirement for buses to stop to pick-up or drop-off passengers along the bus lane.

Recommended Approach

Network planning (see Information Note 1, *Network Planning*) should ensure that cycle travel along a bus lane is minimised, both in terms of number of cyclists and the length of sharing between buses and bikes, where a lane wide enough for bus-bike sharing cannot be provided (see Information Note 4, *Shared Bus-Bike Lanes*).

Cycle networks should be planned and designed to facilitate direct crossing of arterial roads rather than dog-leg crossings involving travel along arterial roads that are also important bus routes.

Bus operators need to be clear that bus lanes are not for the purpose of making up lost time elsewhere on their journey. Bus schedules should be established with intermediate timing points, for the benefit of passengers as well as cyclists – note the TravelSmart bus-stop information (below) that includes detailed location-specific timetables and route maps.

Discussion

Travel time and consistency/reliability of travel time are important service factors in getting people to use public transport. This is often reflected in contractual arrangements for bus operators (particularly when operating under contract to State governments), which may set performance criteria and financial penalties for non-achievement.

It is important from all stakeholders' points of view (bus passenger, bus operator and government) that schedules appropriately reflect normal operating conditions and journey times, and that bus lanes are not seen as a means of catching up time lost elsewhere.

Cyclists have a different operating pattern from buses, with generally slower operating speeds but less need to stop along the way.

The likelihood of an individual bus being held up by a cyclist depends upon:

- The number of cyclists;
- The speed of cyclists;
- The range of cyclists speeds;
- The desired speed for buses;
- The length of the bus lane – more correctly, the length of time cyclists take to travel the length of the bus lane; and
- The extent of passing opportunities.

Similarly, the incidence of bus delay, overall, will increase with the number of buses using the bus lane.

In general terms, the incidence of delay to buses will:

- increase with the number of cyclists, the number and speed of buses and the distance for which the lane is shared; and
- decrease with higher cyclist speed and increased width of lane.

Uphill grades can significantly reduce cyclist speed, especially where the grade continues for some distance (see Information Note 14, *Facility Design on Hills*).

Conversely, cyclists will be held up by buses where there are frequent bus stops, especially for picking up passengers where ticketing can add significantly to boarding times.

In practice, bus lanes are most likely to be installed on arterial roads where commuter, rather than local cycling, is the predominant cycle use. Commuter cyclists are generally more experienced and travel faster than those who cycle for any other purpose. Overall cycle journey speeds (origin to destination) are around 20km/h for commuters, compared to 10-12km/h for other trip purposes, implying an operating speed of at least 25km/h (Perth Travel Surveys, 1986).

The US FHWA (1998b, Section 4) recommends that 25km/h be used as the average bicycle running speed on arterial roads and notes that *this speed falls within the range of speeds from previous studies*. However, cycle speed will vary along any route, depending on gradients, traffic volume and the extent to which traffic conditions force slowing or stopping. With the exception of having to stop for a bus picking up or dropping off passengers, cyclist speed is likely to be higher in a bus lane than in a relatively congested general traffic lane.

In addition, FHWA (1998b, Section 2) notes that *the standard deviation* [ie the variation of speed between cyclists] *will be relatively smaller for those facilities used primarily by commuters*. Bus priority facilities are more likely to be provided on arterial roads which are, in turn, most likely to be used by commuter cyclists rather than other less experienced cyclists.

References

FHWA (1998b). *Capacity Analysis of Pedestrian and Bicycle Facilities: Recommended Procedures for the 'Bicycles' Chapter of the Highway Capacity Manual*. Federal Highway Administration, US Department of Transportation: Washington DC, USA.

http://www.fhwa.dot.gov/tfhrc/safety/pubs/98-108/contents.htm#contents

Perth Travel Surveys (1986). *Perth Travel Surveys*. Department for Planning and Infrastructure: Perth, WA.

BUS DRIVER AND CYCLIST ATTITUDES AND BEHAVIOUR

Issue

Bus drivers are specifically trained for their job and spend a large amount of time on the road. Nevertheless, cyclists can feel unsafe in close proximity to buses, especially when the bus is driven too close or too fast for comfort. Uncaring or unknowing behaviour by drivers towards cyclists adversely affects cyclist safety. Equally, irresponsible or unpredictable behaviour by cyclists adversely affects their own safety but also creates potential problems for and hostility from other road users, including bus drivers. Although behaviour is influenced by attitudes, it is not the only determinant; poor attitudes primarily result in dangerous behaviour where buses and bikes come into conflict through having to share the same space.

Recommended Approach

The most effective approaches to behavioural issues do not always relate to modifying driver or cyclist attitudes. Provision of adequate and, where possible, differentiated, space for buses and bicycles (see *Information Note 4, Shared Bus Lanes*, and *Information Note 5, Separate Bus and Bike Lanes*), will reduce the perceived conflict and is also more forgiving of error, whatever the cause. If this is the predominant approach, bus drivers will be less likely to be aggressive towards cyclists in specific locations where the space available prevents the bus from overtaking the cyclist safely.

Differentiation of bus and bicycle networks (see *Information Note 1, Network Planning*) reduces the likelihood of a bus being held up by a cyclist and the consequent potential to trigger conflict and aggressive behaviour. Such behaviour may be as much due to commercial or customer service imperatives (see *Information Note 19, Commercial and Contractual Imperatives*) as to poor bus driver attitudes or training.

Nevertheless, bus driver training should include specific attention to sharing the road, including bus lanes, with cyclists. Issues to be addressed include:

- Where to expect cyclists on the road – cycle routes as well as lateral positioning
- Conspicuity of cyclists – looking for ‘small’ objects not just motor vehicles
- Speeds of cyclists, at a point in time and over a length of road.

It is also important that cyclists are made aware of how to behave when sharing space with buses. This should include taking opportunities to get out of the traffic stream temporarily to allow buses to pass, especially on long lengths of narrow bus lane, and riding in single file to maximise opportunities for buses to pass without intruding into the adjacent traffic lane.

The leaflets produced for Auckland and Wellington, New Zealand, (reproduced at the end of this Information Note) are good examples of appropriate information dissemination highlighting the responsibilities of both cyclists and bus drivers.

Discussion

To professional drivers, whether of buses or commercial vehicles, ‘time is money’. A UK survey found:

“When prompted, all the professional drivers, regardless of whether they were carrying goods or passengers, tended to be less accepting of cyclists’ presence on the roads they were using. They felt that their livelihood was being interfered with – particularly if they were held up by a cycle, which was obviously slower than other vehicles, within their lane. It was reported that being caught behind a cyclist added further to the pressure on their work schedules”

(Basford et al, 2002, p7).

Bus drivers in New South Wales, in a workshop run in conjunction with the development of these Guidelines, identified a number of issues relating to cyclists that are of concern to them:

- Aggressive attitudes of cyclists;
- Lack of enforcement of traffic regulations on cyclists;
- Slow cyclists hindering bus operations;
- Leapfrogging at intersections and subsequent repeated holding up of buses;
- Riding alongside bus, including overtaking on the left of turning bus (see *Information Note 7, Bus Left Turn*)
- Not using shared path or cycle path where available;
- Poor cyclist visibility, especially when approaching from behind the bus;
- Sharing narrow lanes with bicycles; and
- Knowledge of how to use roundabouts.

In the specific case of scheduled public transport services operated under contract (usually to State governments), the pressure to maintain schedules may be reinforced by financial penalties associated with late running as part of the contract (eg Perth, Western Australia). More generally, journey time and predictability of bus arrival are important factors in providing the level of customer service required for buses to compete effectively with the private car (see Information Note 19, *Contractual and Commercial Imperatives*).

Attitudes are one factor in driver behaviour, but it is also important to set realistic and achievable schedules for buses and to recognise that sharing of bus lanes represents a sharing of the benefits of priority rather than a negation of those benefits (see Information Note 18, *Bus Lane Regulations*).

A common experience among cyclists is of a bus pulling across to the kerb without having fully-passed the cyclist or without allowing adequate clearance for the cyclist to respond to the bus slowing (eg for a bus stop). The Cities of Auckland and Wellington, New Zealand, advise bus drivers in the following terms (see page 3 of this Note):

Don't overtake a cyclist near a bus stop unless your bus will get to the stop well ahead of the cyclist. You should leave sufficient distance to enable the cyclist to move across the lane to pass the bus without making a sudden swerve.

If this is not possible, slow down and let the cyclist ride past the bus stop first.

Bus Pulling to Kerb too Close in Front of Cyclist

Allen (2004) identifies some 'common errors of bus drivers' as follows:

- Overtaking with too little clearance, leaving the bicyclist too little room to avoid obstacles without the risk of colliding with the side of the bus
- Turning or merging (toward the bicyclist) before having finished overtaking
- Merging into the path of a bicyclist when pulling out from a bus stop
- Not pulling close to the kerb at a bus stop, thereby encouraging bicyclists to overtake between the bus and the kerb and in the path of passengers alighting from or getting onto the bus.

This last should not be a major problem in Australia as all regular public transport bus fleets are progressively replaced by low-floor accessible buses and drivers are trained to stop close to and parallel to the kerb at stops to allow deployment of the wheelchair ramp. However, illegal parking on the upstream side of bus stops can prevent bus drivers from being able to approach the kerb in the optimum way. This underlines the importance of continuity and consistency of provision in a broad context for buses and bicycles, such as the UK Red Routes and Greenways (see Information Note 2, *Continuity and Consistency*) in which parking control, management and enforcement is an integral part.

The corresponding errors of cyclists are stated to be:

- Overtaking on the kerb side of a stopped bus (see last point, above)
- Overtaking too close to the side of a bus.

In addition, cyclists may be seen as not being considerate to bus users if they do not take opportunities to pull left (including pulling off the road – for example at a driveway – if there is a build-up of buses behind) to allow buses to pass, especially where there may be no other passing opportunity for some distance. However, many bus lanes are either not long enough or do not carry enough buses for this to be a frequent occurrence. In general traffic lanes, buses may move out of the lane to pass another vehicle (including a bicycle), but common sense and courtesy need to prevail.

Rural Roads

Most bus-bike interaction occurs on urban roads. However, cyclists also use rural roads, on which traffic speeds are often high and the ability to provide lateral separation from passing motor vehicles is less. Air turbulence caused by passing large vehicles, especially at high speed, is a real safety hazard for cyclists, as well as adversely impacting on the amenity of the cycling experience.

It is important that rural and long-distance bus and coach drivers are aware of the dangers of passing too close to cyclists and, when passing, provide adequate lateral clearance and ensure they are well past the cyclist(s) before moving back to the left side of the road.

Cyclists need to ride in a way that facilitates passing by buses and other vehicles, including riding in single file (especially on 2-lane, 2-way roads) when a bus is approaching and in small rather than large groups.

References

Allen, John S (2004). *Bike and Bus*. John S Allen's Bicycle Facilities, Laws and Programs Pages.
http://www.bikexprt.com/bikepol/facil/lanes/bikebus.htm

Basford, L, Reid, S, Lester, T, Thomson, J and Tolmie, A (2002). *Drivers' perceptions of cyclists*. Report TRL549, TRL Limited: Crowthorne, Berkshire, England. ISSN 0968-4107.
http://www.trl.co.uk/static/dtlr/cycling/TRL549.pdf

What cyclists would like bus drivers to know

1 Passing a cyclist

Pull out of the bus lane to pass a cyclist only if at least 1m can be maintained between your bus and the cyclist. If the centre lane is blocked by traffic, stay at least 4m behind the cyclist until you can overtake safely.

2 Pulling into bus stops

Don't overtake a cyclist near a bus stop unless your bus will get to the stop well ahead of the cyclist. You should leave sufficient distance to enable the cyclist to move across the lane to pass the bus without making a sudden swerve. If this is not possible, slow down and let the cyclist ride past the bus stop first.

3 Pulling out of bus stops

You must indicate your intention to pull out at least 3 seconds before pulling out – this is law. Check there are no cyclists overtaking the bus, or close behind the bus before pulling out. If you see a cyclist, try to make eye contact so they know that you have seen them.

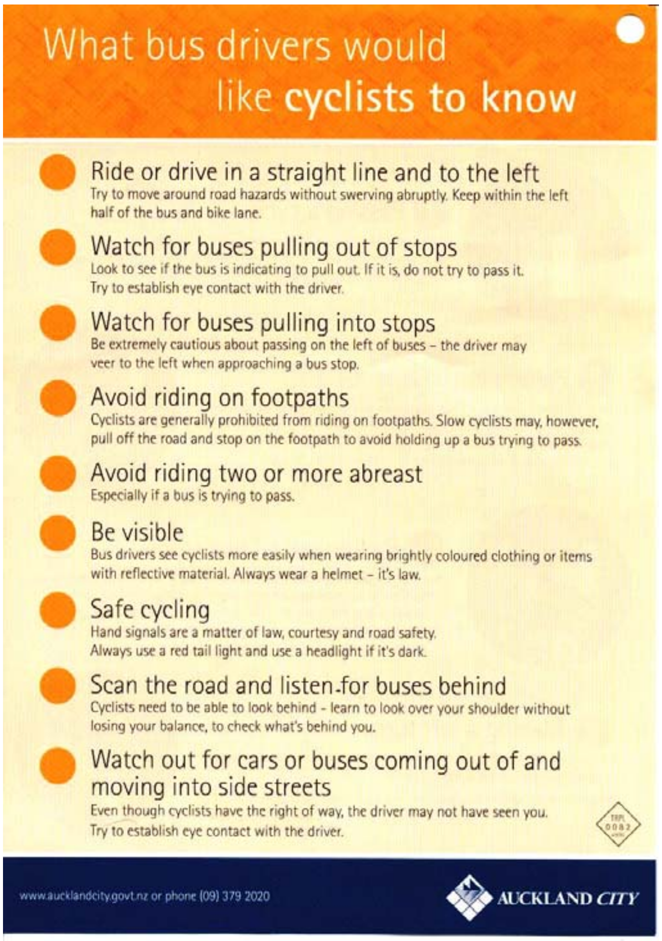
4 Making a left turn

If turning left into a side street, take care not to cut in front of cyclists who may be travelling straight ahead at the intersection.

The guidelines for approaching bus stops also apply to left hand turns.

www.aucklandcity.govt.nz or phone (09) 379 2020

AUCKLAND CITY



What bus drivers would like cyclists to know

Ride or drive in a straight line and to the left
Try to move around road hazards without swerving abruptly. Keep within the left half of the bus and bike lane.

Watch for buses pulling out of stops
Look to see if the bus is indicating to pull out. If it is, do not try to pass it. Try to establish eye contact with the driver.

Watch for buses pulling into stops
Be extremely cautious about passing on the left of buses – the driver may veer to the left when approaching a bus stop.

Avoid riding on footpaths
Cyclists are generally prohibited from riding on footpaths. Slow cyclists may, however, pull off the road and stop on the footpath to avoid holding up a bus trying to pass.

Avoid riding two or more abreast
Especially if a bus is trying to pass.

Be visible
Bus drivers see cyclists more easily when wearing brightly coloured clothing or items with reflective material. Always wear a helmet – it's law.

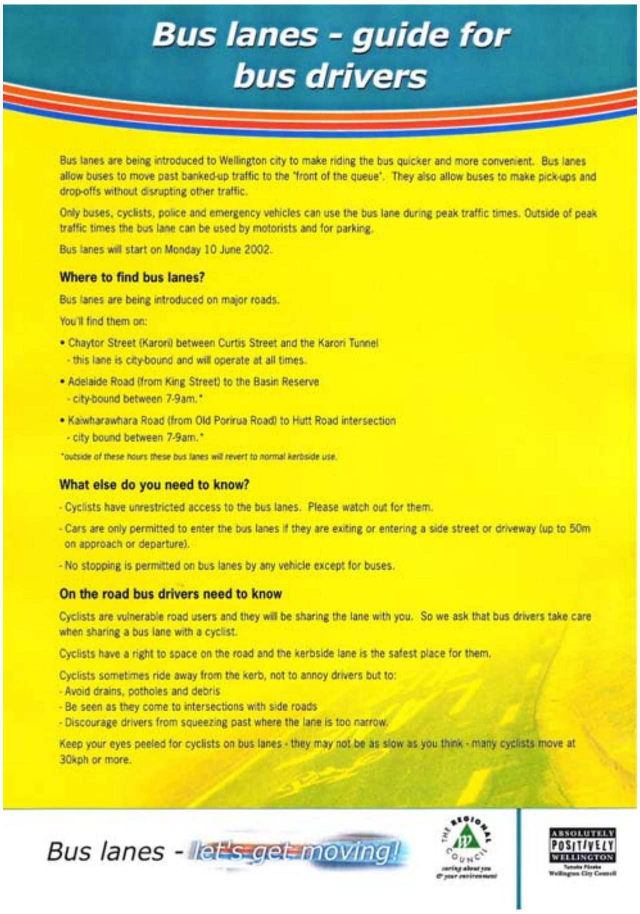
Safe cycling
Hand signals are a matter of law, courtesy and road safety. Always use a red tail light and use a headlight if it's dark.

Scan the road and listen for buses behind
Cyclists need to be able to look behind – learn to look over your shoulder without losing your balance, to check what's behind you.

Watch out for cars or buses coming out of and moving into side streets
Even though cyclists have the right of way, the driver may not have seen you. Try to establish eye contact with the driver.

www.aucklandcity.govt.nz or phone (09) 379 2020

AUCKLAND CITY



Bus lanes - guide for bus drivers

Bus lanes are being introduced to Wellington city to make riding the bus quicker and more convenient. Bus lanes allow buses to move past banked-up traffic to the "front of the queue". They also allow buses to make pick-ups and drop-offs without disrupting other traffic.

Only buses, cyclists, police and emergency vehicles can use the bus lane during peak traffic times. Outside of peak traffic times the bus lane can be used by motorists and for parking.

Bus lanes will start on Monday 10 June 2002.

Where to find bus lanes?

Bus lanes are being introduced on major roads.

You'll find them on:

- Chaytor Street (Karori) between Curtis Street and the Karori Tunnel
  - this lane is city-bound and will operate at all times.
- Adelaide Road (from King Street) to the Basin Reserve
  - city-bound between 7-9am.*
- Kaiwharawhara Road (from Old Porirua Road) to Hutt Road intersection
  - city bound between 7-9am.*

**outside of these hours these bus lanes will revert to normal kerbside use.*

What else do you need to know?

- Cyclists have unrestricted access to the bus lanes. Please watch out for them.
- Cars are only permitted to enter the bus lanes if they are exiting or entering a side street or driveway (up to 50m on approach or departure).
- No stopping is permitted on bus lanes by any vehicle except for buses.

On the road bus drivers need to know

Cyclists are vulnerable road users and they will be sharing the lane with you. So we ask that bus drivers take care when sharing a bus lane with a cyclist.

Cyclists have a right to space on the road and the kerbside lane is the safest place for them.

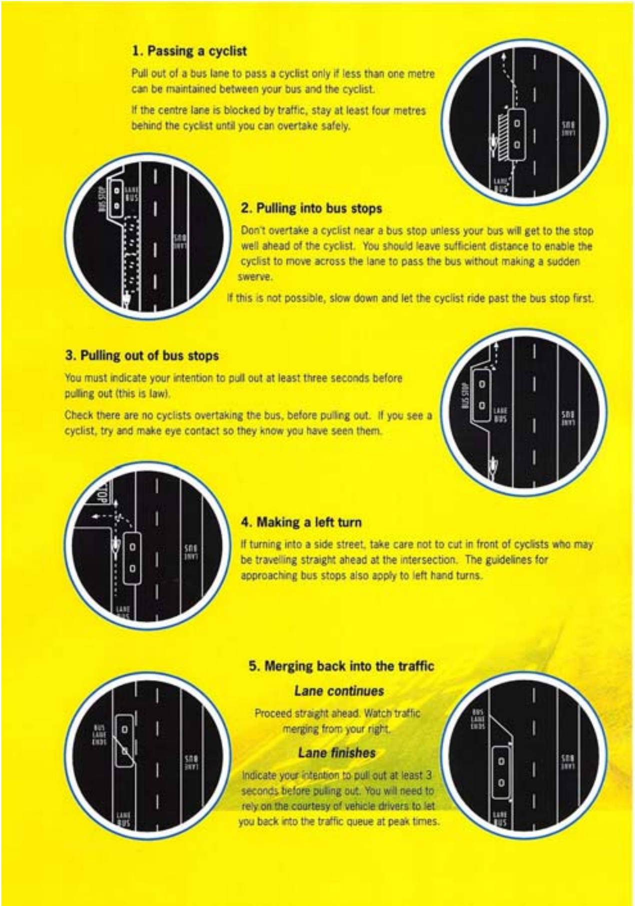
Cyclists sometimes ride away from the kerb, not to annoy drivers but to:
- Avoid drains, potholes and debris
- Be seen as they come to intersections with side roads
- Discourage drivers from squeezing past where the lane is too narrow.

Keep your eyes peeled for cyclists on bus lanes - they may not be as slow as you think - many cyclists move at 30kph or more.

Bus lanes - let's get moving!

The Regional Council caring about you & your environment

Absolutely Positively Wellington



1. Passing a cyclist

Pull out of a bus lane to pass a cyclist only if less than one metre can be maintained between your bus and the cyclist.

If the centre lane is blocked by traffic, stay at least four metres behind the cyclist until you can overtake safely.

2. Pulling into bus stops

Don't overtake a cyclist near a bus stop unless your bus will get to the stop well ahead of the cyclist. You should leave sufficient distance to enable the cyclist to move across the lane to pass the bus without making a sudden swerve.

If this is not possible, slow down and let the cyclist ride past the bus stop first.

3. Pulling out of bus stops

You must indicate your intention to pull out at least three seconds before pulling out (this is law).

Check there are no cyclists overtaking the bus, before pulling out. If you see a cyclist, try and make eye contact so they know you have seen them.

4. Making a left turn

If turning into a side street, take care not to cut in front of cyclists who may be travelling straight ahead at the intersection. The guidelines for approaching bus stops also apply to left hand turns.

5. Merging back into the traffic

Lane continues

Proceed straight ahead. Watch traffic merging from your right.

Lane finishes

Indicate your intention to pull out at least 3 seconds before pulling out. You will need to rely on the courtesy of vehicle drivers to let you back into the traffic queue at peak times.

AUSTROADS

YOUNG OR INEXPERIENCED CYCLISTS

Issue

Young and/or inexperienced cyclists are least able to cope with complex traffic environments. They are likely to travel more slowly, be less predictable than more experienced cyclists and more likely to be unsettled by the close proximity of large and/or fast vehicles. They are, therefore, more at risk of coming into conflict with other road users and more likely to be perceived as an impediment to buses, in particular.

Recommended Approach

Wherever possible, local cycle routes should avoid arterial roads and concentrations of buses or other heavy vehicles (see Information Note 1, *Network Planning*). Where this cannot be achieved, visually- or physically-separated facilities should be provided wherever possible.

Where local cycle routes cross bus routes, particular attention should be paid to sight lines (for both bus drivers and for cyclists) and to signage to advise bus drivers of the likely presence of cyclists crossing. Bus stops should not be located where the presence of a bus would restrict the cyclist's ability to see motor vehicles that may overtake the stopped bus (ie on the upstream side of the intersection); alternatively, road treatment should preclude the passing of a stopped bus (eg a raised median, which may also serve as a staged crossing facility for cyclists and pedestrians).

Discussion

The cognitive skills of young (particularly primary school aged) cyclists are not fully developed and young children have little knowledge of road traffic laws.

In particular, young/ inexperienced cyclists are likely to have difficulty interpreting complex road and traffic situations and responding appropriately to unexpected events.

Photo: Road Directorate (2000)

Many trips by young cyclists will be short (eg to and from primary school or friends' homes in the surrounding area) so there is limited need for trips to be undertaken on arterial or other busy roads. Generally, the appropriate facility for primary school children is an off-road path (including a footpath under the National Road Traffic Rules) or a quiet residential street. In the latter instance, local area traffic management initiatives (see Information Note 12, *Local Area Traffic Management*) may be desirable to slow motor vehicle traffic on local streets (even with the 50km/h general urban speed limit) and enhance route continuity for cyclists.

In some cases, local roads that are also local bicycle routes may be closed at the junction with an arterial road in order to improve the safety of cyclist crossing – by simplifying traffic movements. However, this will not always work – for example where traffic on the arterial is heavy, continuous and travelling at a relatively high speed.

These considerations are especially important where there is likely to be a concentration of young or inexperienced cyclists, with schools being the most obvious example. However, libraries, recreation and aquatic centres, and other community facilities should also be considered.

Schools and Other Community Facilities Need Special Attention

Photo: Road Directorate (2000)

Reference

Road Directorate (2000). *Collection of Cycle Concepts*. Road Directorate: Copenhagen, Denmark.
http://www.vd.dk/wimpdoc.asp?page=document&objno=17291

Bus-Bike Interaction Within The Road Network

Information Note No 22 February 2005

AUSTROADS

BUS REAR VIEW MIRRORS

Issue

External rear view mirrors on buses may be at cyclists' head height. This may pose a hazard for cyclists when operating in close proximity to buses.

Recommended Approach

Bus driver training should ensure that drivers are aware of the need to look out for overtaking cyclists, especially when initiating a lateral movement in the roadway, and of the speed at which cyclists may approach and overtake.

Cyclists should be made more aware of the importance of forward conspicuity, especially when the bus driver's only view of the cyclist may be through a rear vision mirror.

Where there is visual separation of bicycle space on the roadway (a bike lane or a sealed shoulder commonly used by cyclists) on a roadway which is also a bus route or in the case of a bus bay, consideration should be given to using wider line-marking to encourage a greater degree of separation between buses and bikes, especially where the bus lane is narrow and/or hemmed in by large vehicles using the adjacent traffic lane.

The Australian Design Rule for rear vision mirrors (ADR 14/02) should be reviewed and clarified to define 'collapsibility' criteria (14.4.3) appropriate for contact with a cyclist (ie with respect to the impact or force required for collapse to the 150mm position.

Discussion

The positioning of external rear vision mirrors on buses and trucks is governed by the Australian Design Rules, which state that mirrors shall not protrude more than 230mm beyond the body of the bus (see box).

Whilst there is no stipulation on the height of such mirrors above the roadway, it will generally be the case that the kerbside mirror is located as high as possible on a bus and forward of the front entry door so that the driver can see the rear (exit) door over the heads of boarding passengers. This mirror will not intrude into the operating space of a cyclist when positioned to the left of a bus (for example, in a kerbside bike lane or a shared bus-bike lane). Consequently, the nearside external rear vision mirror of a bus should not interfere with the operation of a cyclist when a bus overtakes the cyclist.

Australian Design Rule 14/02: Rear Vision Mirrors

14.4 REQUIREMENTS FOR MD3; MD4; ME; NB; AND NC VEHICLES ONLY [Note: A standard route service bus is class ME]

14.4.1 There shall be affixed to every vehicle a mirror or mirrors so designed and fitted and of such dimensions as to be capable of reflecting to the driver as far as practicable a clear view of the road to the rear of him and of any following or overtaking vehicle.

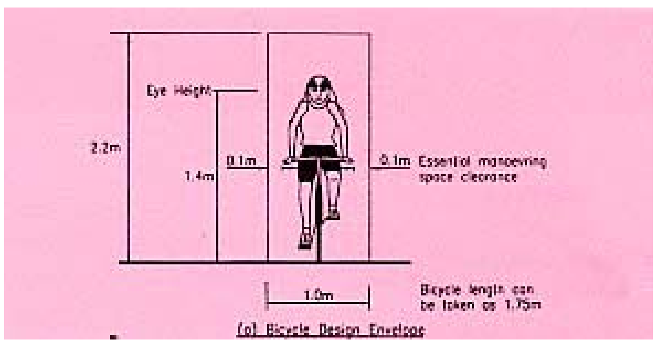
14.4.2 At least one such mirror shall be affixed to each side of the vehicle and may project 150 mm beyond the point of '*Overall Width'* of the vehicle or the '*Overall Width*' of any trailer it may be drawing-

14.4.2.1 if the vehicle is a goods vehicle or an omnibus;

14.4.2.2 if the trailer be of greater width than the drawing vehicle; or

14.4.2.3 in any case where, because of the manner in which the vehicle is constructed or equipped, or the fact that it is drawing a trailer or for any other reason, the driver could not, by means of a mirror affixed to the inside of the vehicle, have reflected to him as far as practicable a clear view of the road to the rear of him and of any following or overtaking vehicle.

14.4.3 The mirrors may project 230 mm on each side beyond the point of '*Overall Width*' of the vehicle provided that the mirror is capable of collapsing to 150 mm.



The off-side external rear vision mirror is generally mounted at a lower level to give the driver a clear longer-distance view of what is behind. This mirror is typically at a height of 1.4-1.6 metres above the roadway and therefore can enter into the operating space of a cyclist passing the bus on the driver's side. However, the maximum protrusion beyond the body of the bus is such that it is unlikely to intrude into the path of a cyclist unless some other part of the bicycle (handlebars or pedals) is already in contact with the bus or the cyclist is leaning towards the bus.

To the extent that there is a problem, it is more to do with buses moving laterally in the roadway (eg pulling away from a kerbside bus stop) when the driver might not have seen a passing cyclist (or perhaps has underestimated the speed of the cyclist) and the front corner of the bus, where the mirror is mounted, becomes the critical point of potential contact. The solution to this lies:

- partly in greater awareness by bus drivers of the likelihood of cyclists passing and the speed at which they are likely to do so, coupled with a greater awareness by cyclists of the importance of forward conspicuity (so that he/she can be seen by the driver of vehicles being overtaken) and the importance of not overtaking a bus which is indicating that it is about to move to the right on the roadway; and
- partly in better conformity by cyclists with the road rule that gives priority to buses moving out of bus bays into the traffic stream and in certain other circumstances. Rule 77 of the Australian Road Rules states:

  (1) A driver driving on a length of road in a built-up area, in the left lane or left line of traffic, must give way to a bus in front of the driver if:

  (a) the bus has stopped, or is moving slowly, at the far left side of the road, on a shoulder of the road, or in a bus-stop bay; and

  (b) the bus displays a give way to buses sign and the right direction indicator lights of the bus are operating; and

  Give way to buses sign

  This sign is displayed on buses.

  (c) the bus is about to enter or proceed in the lane or line of traffic in which the driver is driving.

Correspondingly, it is important that buses clearly display the 'give way to buses' sign in an appropriate place at the right rear of the vehicle. Placing the sign on the interior of a rear window, whilst protecting the sign itself, may be higher than desirable for some road users and can lead to diminished visibility (for example, with dirty glass or light reflection).

Signs Can Be Obscured by Dirt or Reflection

BUS EXHAUST FUMES

Issue

Poorly-maintained buses may emit large quantities of exhaust emissions, especially particulates, in stop-start operation including where cyclists may be required to wait behind a bus (at signals or bus stops) because no passing opportunities are available.

Recommended Approach

Network planning and facility design should minimise the extent to which cyclists are forced to wait behind stopped buses. This may include enhanced bus priority at traffic signals.

Bus operators should progressively adopt Euro 4 emission standards for new buses and carry out regular emissions checks on all buses.

Alternative, cleaner, fuels (to diesel), such as natural gas, should be introduced where it is economic to do so. In the longer term, clean fuels such as hydrogen and electricity should be encouraged for urban bus fleets.

The location of bus exhausts should, wherever possible, be away from the kerbside.

Discussion

It can, be unpleasant riding a bicycle behind a motor vehicle and breathing in its exhaust emissions. Whether it is a danger to health or, more correctly, whether it is more of a danger to health than sitting in a car in the same stream of traffic is less clear-cut. Diesel vehicles add particulates to the pollutant mix, including so-called 'fine particulates' that may not be visible but have been linked to significant health problems in people with higher levels of exposure.

Progressive replacement of buses with newer diesel technology and alternative fuels such as natural gas will reduce the contribution of buses to the level of emissions faced by all road users.

A study by the International Centre for Technology Assessment has concluded that occupants of cars are exposed to much higher levels of air pollution than those who ride buses or trains and those who walk or cycle (ICTA, 2000). This confirms the earlier findings of the Environmental Transport Association (ETA, 1997). However, this needs to be balanced against the duration of exposure.

Studies conducted over the past two decades conclusively show that the shell of an automobile does little to protect the passengers inside from the dangerous air pollutants, including respiratory irritants, neurological agents, and carcinogens, commonly found in the exhaust of gasoline and diesel vehicles. In fact, the levels of exposure to most auto pollutants, including potentially deadly particulate matter (PM), volatile organic compounds (VOCs) and carbon monoxide, are generally higher for automobile drivers and passengers than at nearby ambient air monitoring stations or even at the side of the road (ETA, 1997; ICTA, 2000).

Similarly, drivers' exposures to these pollutants significantly exceed the significant exposures endured by bicyclists, pedestrians, and public transit riders. The amount of time people spend in their cars is increasing - not only are they driving further, but they are taking longer to get where they want to go. Several in-car pollution studies also considered pollution exposure in other environments and found that a person who commutes to and from work in a car each day may amass nearly a quarter of his or her total daily exposure to VOCs, PM, and other pollutants during those few hours he or she spends in the car.

Removing both cyclists and bus passengers from the direct vicinity of the main sources of vehicle exhaust pollution will further enhance these benefits as will any reduction in the duration of exposure.

Similarly, the smaller number of motor vehicles in a bus lane, compared to the pre-existing traffic situation, will reduce the unavoidable proximity of cyclists and bus passengers to exhaust emissions from buses themselves. In addition, buses in bus lanes will have to stop and start less frequently and, when in motion, cyclists will have greater opportunity to maintain space between themselves and the exhaust of the bus in front.

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Bus-Bike Interaction Within The Road Network

Information Note No 24 February 2005

AUSTROADS

BICYCLE STORAGE FACILITIES

Issue

Bicycle storage facilities are a key element in fostering a complementary relationship between cycling and public transport, to the benefits of both. Secure bicycle parking has been more heavily promoted with rail public transport than with bus, at least in Australia, and there are few examples of bicycle parking at regular bus stops.

Recommended Approach

Identify bus stops that meet the following criteria to provide bicycle parking:

- A high proportion of longer-distance bus journeys
- A bicycle catchment that is not served by adequate alternative public transport access with secure bicycle parking
- Active or passive surveillance to enhance security of parked bicycles

Discussion

In some places (eg Brisbane) bicycles may be carried on buses (usually on front-mounted racks), but more commonly cyclists wishing to combine bike and bus for a journey have to park their bike before continuing by bus.

At major bus access points, usually those serving longer-distance and limited-stop or express services, facilities for cyclists using buses should be similar to those provided on the train system. Thus, to effectively integrate cycling and the bus service, suburban bus stations should provide lockers, security and lighting.

Bus routes and bus stop spacings are heavily influenced by extent to which people are willing to walk from their houses to the access point for a bus service. Bicycle parking is not required at every bus stop, as the bicycle confers upon its rider the ability to travel substantially further to such an access point.

Austroads (1999, p134) suggests that *bicycle parking facilities should be provided at common commuting and recreational destinations of bicycle trips* [including] *… railway stations, bus terminal and interchanges ….*

In practice, the emphasis in Australia has been on bicycle parking at train and, to a lesser extent, bus stations as a result of the greater concentration of passengers and services at those places (see, eg, RTA, 1999, p78). The focus on train stations may also reflect the generally longer nature of train than bus trips and, hence, the higher proportion that are beyond 'cycle all the way' distance. However, there may be intermediate bus stop locations that could benefit from some formal bicycle parking provision, just as there are intermediate train stations between major interchanges that have bicycle parking facilities, although the issue of security would suggest that these would need to be in or near at least local activity centres.

Informal bicycle parking at bus stops may provide an indication of where cyclists benefit from cycle access to bus and feel reasonably comfortable about the level of security inherent in the location. More formal and secure facilities, including hard standing, fixed racks and possibly weather protection, would enhance the level of usage.

Informal and Formal Bicycle Parking at Bus Stops

Future bicycle parking facilities at bus stops will be covered racks.

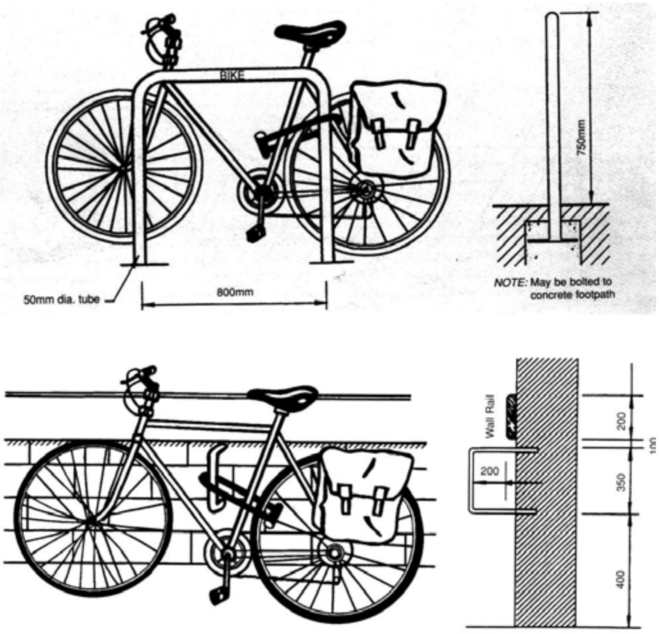
Source: Road Directorate (2000)

Where there are no locations identifiable through informal use, there would be value in identifying bus stops that meet the following criteria to provide bicycle parking:

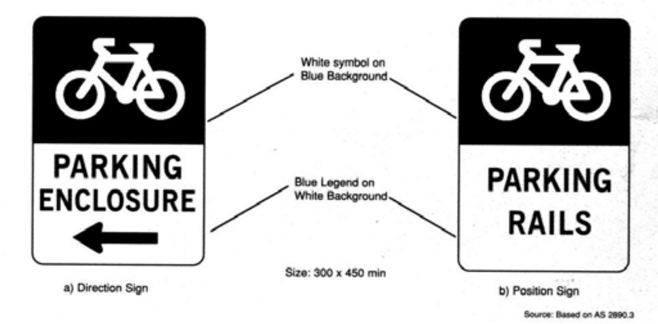
- A high proportion of longer-distance bus journeys
- A bicycle catchment that is not served by adequate alternative public transport access with secure bicycle parking
- Active or passive surveillance to enhance security of parked bicycles

Austroads (1999, Section 10) provides guidance for the provision, location and installation of bicycle parking facilities including free-standing and wall-mounted types (below).

Types of Bicycle Parking



It is important that the availability of bicycle parking facilities is known. This should be achieved through appropriate designation of locations with bicycle storage on bus timetables and other marketing/ information materials and through signage at the actual location.



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APPENDIX A: SURVEY FORM

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ABN 68 004 620 651

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Australia

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Leederville WA 6903
Australia

In reply please quote : RC5133

12 November, 2003

Bus and Bike Interaction within the Road Network

ARRB Transport Research has been commissioned to undertake a project on 'Bus and Bicycle Interaction within the Road Network' for the Australian Bicycle Council, with the objective of developing best practice guidelines.

A key initial stage is to identify the issues and we are seeking your assistance at this early stage to ensure that we cover all the bases and understand the context from the start.

a) What are the key issues that arise from interaction between buses and bikes in the road network?

b) What options can you suggest for resolving conflicts or adding value to beneficial interaction?

c) What standards or guidelines (local, State or national, other than the Austroads Guide to Traffic Engineering Practice Part 14, Bicycles) are you aware of that might apply to these issues?

d) Do you wish to nominate any specific situations that might be useful as case studies? If you have photographs that can be e-mailed, even better.

We are not seeking detailed information at this stage, as our job is to work through the possible solutions and propose ways forward. However, we need your assistance to ensure that we get the scope right in the first place.

As a 'thought starter', we have identified a number of potential issues. No doubt this list is incomplete and your comments would be very much appreciated.

- Shared Transit space (Bicycles in bus lanes);
- Parallel transit space (Cycle lane/bus lane);
- Intersecting (conflicting) space -
  - bus stops;
  - bus stations;
  - turning movements;
  - junctions;
  - roundabouts;
  - Schools;
- Prescriptive nature of cycle lanes;
- Visibility / predictability / awareness;
- Speed differentials;
- Off-road opportunities;
- Network separation;
- Signal Priorities;
- Driver education;
- Special users of buses -
  - Patrons with disabilities;
  - Ramps;
- Bikes on buses;
- Cycle access to public transport nodes.

As always, time is of the essence, bearing in mind the closeness of the Christmas/New Year period, so that we can commence the developmental work early in the New Year. **Your responses by Friday 5 December would be greatly appreciated. Reply by fax (08 9227 3030), mail (PO Box 512, Leederville, WA 6903) or e-mail** stevey@arrb.com.au.

Ian Ker
Project Manager

Space has been provided overleaf for your response

ARRB Transport Research Ltd - advancing safety and efficiency in transport through knowledge

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Bus and Bike Interaction within the Road Network

What are the key issues that arise from interaction between buses and bikes in the road network?

What options can you suggest for resolving conflicts or adding value to beneficial interaction?

What standards or guidelines (local, State or national, other than the Austroads Guide to Traffic Engineering Practice Part 14, Bicycles) are you aware of that might apply to these issues?

Do you wish to nominate any specific situations that might be useful as case studies? If you have photographs that can be e-mailed, even better.

Contact Information (optional)

Name:.. Organisation...

Phone: .... E-mail ....

Your responses by Friday 5 December would be greatly appreciated.
Reply by fax (08 9227 3030), mail (PO Box 512, Leederville, WA 6903) or e-mail stevey@arrb.com.au.

INFORMATION RETRIEVAL

Austroads (2005), **Bus-Bike Interaction within the Road Network**, Sydney, A4, 103pp, AP-R266/06

Keywords:

Abstract:
Buses and Bikes are at opposite ends of the spectrum in terms of size, mass and manoeuvrability but frequently operate in the same road space, especially adjacent to the kerb and at intersections. Both buses and bicycles are effective alternatives to the private car for travel in our towns and cities and are being promoted by governments on this basis, but they can come into conflict as well as working together.

This report reviews the interaction between buses and bicycles within the road network and suggests ways in which any adverse impacts on cyclists or bus operators and passengers can be minimised. Issues and ways of addressing them were identified in consultation with both bus and bicycle stakeholders, to ensure that the outcomes reflected a balanced view of bus-bike interaction.

Specific Issues have been addressed in specific 'Information Notes', which are included as part of this report. These are also available as individual documents, in electronic form, on the website of the Australian Bicycle Council (http://www.abc.dotars.gov.au).

These Information Notes do not replace existing guidelines (for example, the Austroads Guides to Traffic Engineering Practice) but are intended to complement them, to draw attention to issues that may need to be addressed in specific situations and to suggest ways in which they can be resolved or, at least, adverse impacts for cyclists and bus operators and passengers can be minimised. Users should also refer to local State or Territory Guidelines for bicycle facilities.

The information in these Information Notes should be considered in the current review and rewrite of the Austroads *Guide to Traffic Engineering Practice*.